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Geographical Information Systems Applications for Schools – GISAS

Tino Johansson (ed.)

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Foreword

Welcome to the fascinating world of GIS and acronyms! It all started three years ago, when our project proposal received funding from the Socrates- Minerva Programme of the European Commission. This moment is a flashback from the early days of the GISAS (Geographical Information Systems Applications for Schools) project when I prepared the first project meeting in Helsinki in 2003 during a misty autumn morning, just like the one today. The schedule and slides were full of acronyms, such as GIS, GPS, WGS84, BSCW, ESRI, TIFF, JPG, ICT, IMS, FTP, only to mention a few. Being aware that the partners were not all geographers but came from a wide variety of subjects from German language to physics, I had to clarify each acronym in turn. One of my aims for the project was that the partners would all become familiar with these acronyms, vocabulary and basic functions of GIS by the end of the project so that when I prepare the slides for the final meeting of the project during the SM@K week in Geel, Belgium, I can only use the acronyms without clarifying them in detail for the partners.

In October 2003, I and my esteemed colleagues from nine European countries began to work on a huge task of introducing Geographical Information Systems into secondary schools. The researchers of the consortium were already familiar with some of the pilot projects carried out nationally in promoting Geographical Information Systems in secondary education but for most of the partner school teachers the project was a leap into the unknown. Also, the geographical scope of the project was much larger than in any other previous Geographical Information Systems education projects in Europe. Thus, we had to cope with a variety of curricula, learning cultures, school timetables, language issues and different facilities. Our aim was to first train the partner school teachers and then involve their students in using Geographical Information Systems at schools.

Geographical Information Systems are computerized systems for managing, analyzing and visualizing spatial data in different scales for various purposes. The heart of these systems is software, which typically links at attribute datatables with a digital map platform. The user can define the visibility and scale of each overlaid map layer on the map window as well as the visual outlook (symbols, colors and sizes) of map objects on each map layer. The possibility to attach attribute data to every map object and to overlay many layers at once allows the user to make queries on the basis of the location or attributes of these spatially located objects. Queries may reveal interrelationships and dependencies between certain map elements and provide a tool for inquiry-based learning. The databases can contain data in both numerical and textual form. These systems are not only tools for geography but can be similarly used, for example, in biology, history and language education. The added value of using GIS in secondary school education lies in the interactive tools of the system. Overlaying different GIS databases, which are visualized on maps and which have a related attribute data table, enables the students to study the interrelationships between different real-life objects and topics.

The GISAS project focused on water quality of the local rivers in the vicinity of the partner schools in different countries. Water quality is just one example of the topics, which can be studied with GIS at schools. Water quality can be studied at geography or biology classes and it also provides many dimensions for environmental education, in general. The partner schools studied the environment of the local community by producing GIS databases on factors and objects having an effect on the water quality of the studied rivers. The students analyzed the water quality both biologically and chemically. The results were collected and visualized on digital maps together with other databases providing information on land use, soil, habitats, infrastructure, etc. Studying the interrelationships between land use, wildlife habitats, recreation and water quality at the local settings and then comparing the findings and results with other schools across Europe was one of the main functionalities of the project. Different man-made and environmental factors were discovered and studied on the basis of their location, attributes or vicinity within a certain buffer radius. According to the inquiry-based learning approach, the students were encouraged to ask questions and to seek answers with the interactive tools of GIS software. They were able to discover the links between the water quality and the polluting factors of the surrounding areas. The partner schools used desktop GIS software for the production and management of the local databases. They also shared and visualized their GIS databases with other partners with an interactive web-based GIS application.

These innovative learning tools allowed the students to create their own databases or access to existing digital databases of different scale from local to European. Learning about water quality and the affecting factors with Geographical Information Systems provided the students a new way to study. The annually accumulated local databases also allowed the creation of time-series and studying the water quality change in time.

The introduction of Geographical Information Systems into the secondary education in Europe does not only support the students' understanding of the environment and stimulate sustainable ways of living but also develops professional skills for the working life and enhances their digital literacy in Geographical Information which is increasingly present in our daily lives, such as the personal navigation tools of the mobile phones or the car navigation systems, just to mention a few. Moreover, Geographical Information Systems and databases are closely linked with some of the Directives of the European Union, such as the Water Framework Directive, for example. This Directive obliges that the draft versions of the River Basin Management Plans must be presented by each member state by the year 2008. These management plans include GIS databases on the ecological (including biological and chemical) condition of the rivers. The EU Water Framework Directive (2000/60/EC) sets out public participation as one of the major element in these management plans. Public participation and inquiry-based learning with the GIS tool go hand-in-hand as the increasing knowledge on the environmental and human impacts on water quality leads to local action. Citizens with GIS knowledge may create their own databases to counter-map the river basins according to their viewpoints and preferences and speak the same GIS language with the water management authorities. Understanding the functions of the professional GIS tools and learning to find and use the available Geographical Information databases is crucial for active citizenship in the information society.

Three years is a relatively short time for introducing new educational tools and learning approaches into the schools, especially when the work is carried out with a foreign language. Learning and adopting new technology is not a simple thing to do and cannot be done in a blink of an eye. Some unexpected obstacles, such as difficulties in obtaining raster maps from the local rivers, forced us to adjust the original plans and aims for the project. Coordinating a pilot project like GISAS required a dynamic approach where the partners' individual backgrounds and needs had to be taken into account. Some partners needed more time and support than the others, which is very natural in a group of actors with a diverse cultural and educational background.

This book is one of the outputs of the GISAS project, summarizing the processes, activities and achieved goals as well as the reflections of the partner schools on the project. Like all the other outputs of the project, the book is a combined effort of many people to whom I would like to express my gratitude. First of all, I would like to thank professor Petri Pellikka for his trust and support. I have been honored to collaborate with him as well as with professor Joseph Van der Schee and professor Gergely Horváth, whose guidance and feedback were very valuable for me during this challenging project. I am also grateful for professor John Westerholm and the Department of Geography at the University of Helsinki, Finland for providing the facilities for the GISAS project. It has been an unforgettable journey into the world of GIS and I am happy that the following people shared this experience with me: Mrs. Ilta-Kanerva Kankaanrinta, Dr. Lea Houtsonen, Dr. Jože Rugelj, Mr. Bojan Močnik, Mrs. Manuella Borghs, Mr. Danny Van der Veken, Mrs. Danielle Lavollée, Mrs. Blandine Faucher, Mr. György Borián, Mr. Zoltán Palotai, Mr. Torbjörn Larsson, Mrs. Ulla Dahlström, Mrs. Solveig Bergsten, Mrs. Cristina Negroni, Mr. Sandro Favini, Mr. Alberto Pietrini, Mrs. Ineta Kruste, Mrs. Anastasija Žukova, Mrs. Georgia Kakardaki, Mr. Periklis Kamaris, Mr. Stamatis Anagnostou, Ms. Ann Van den Meutter, Ms. Tina Bens, Mr. Peter Kempen, Mr. Steve Coeimans, Mrs. Sirkka Staff, Mrs. Outi Kosonen, and all the other teachers participating in the project. A very big thank you goes also to Mr. Manuel Frias Vega, who created the ArcIMS database for us, and Ms. Piritta Peltorinne, who writes her Master's

thesis on the GISAS project. Mr. Mika Siljander helped me to solve a few technical GIS problems and Mrs. Hilkka Ailio kindly offered a helping hand for technical editing, type-setting and layout of the texts for this book. Last but by no means least; I would like to thank all pupils who participated in GISAS exercises, lectures, workshops, conference presentations and data collection.

This project would not have existed without the financial support of the Minerva programme of the Directorate-General of Education and Culture of the European Commission so we are grateful that they decided to fund the GISAS project. ESRI company's generous support and help allowed us to use ArcGIS software and its latest updates during the project so many thanks to Mr. Michael Phoenix, Mr. George Dailey, Mr. Etienne Van Nyverseel, Ms. Pia Lähde, Mr. Frank Holsmuller and Mrs. Ann Johnson for their help and contribution.

Now it is the time of the last acronym in this project. A big GIS for everyone!

Helsinki 27th September 2006

Tino Johansson, project manager of GISAS project

GISAS project partners in the final meeting in Sint-Dimpnacollege in Geel, Belgium on the 21st September 2006.

Gisas project in a nutshell

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Introduction

GISAS (Geographical Information Systems Applications for Schools) was a three-year educational and research project focusing on the incorporation of GIS technologies into secondary and upper secondary school geography and environmental education. The project was funded by the Directorate-General for Education and Culture of the European Commission through the Socrates/Minerva programme. The GISAS project started in October 2003 and by the end of the project in September 2006, a total of 35 in-service teachers and over 220 students had participated in the project activities in seven partner schools in Europe. The represented countries in the project were Belgium, Finland, France, Greece, Hungary, Italy, Latvia, Slovenia and Sweden. GISAS project was coordinated by the Department of Geography at the University of Helsinki, Finland. In addition to the coordinating institution, there were also two other research partners in the project consortium, namely the Finnish National Board of Education, which was responsible of the dissemination of the project and its outputs and supporting the pedagogical planning and research of the project activities. The Jozef Stefan Institute from Ljubljana, Slovenia created a web-based raster image atlas for the project where the partner schools' local databases were uploaded, visualized and shared.

The partner institutions of the GISAS project:

- Department of Geography, University of Helsinki, Finland
- Finnish National Board of Education, Finland
- Jozef Stefan Institute, Ljubljana, Slovenia
- Gaigalava Elementary School, Gaigalava, Latvia
- Institute du Sacré Coeur, La Ville du Bois, France
- Scientific Public Lyceum ´Piero Gobetti´, Bagno a Ripoli, Italy
- Sint-Dimpnacollege, KOGEKA 6, Geel, Belgium
- Széchényi Ferenc Gymnasium, Barcs, Hungary
- Torsberg Gymnasium, Bollnäs, Sweden
- 2nd Lyceum of Larisa, Larisa, Greece

Studying the ecological state of the local rivers with GIS

The partner schools had previously collaborated in European Cooperation on School Education through the COMENIUS programme of the European Commission and had an interest in and experience on assessing local water quality in Europe. The GISAS project used water quality as a thematic content and as a unifying topic for schools. The partner schools collected water quality data from local rivers twice a year, analysed it and visualized the results by overlaying the water quality database with other GIS data layers on local raster map. The partner schools monitored water quality of their local water bodies with BISEL (Biotic Index at Secondary Education Level) method, see figure 1. This method uses aquatic macroinvertebrates as biological indicators of water quality (De Pauw et al. 1999). In addition to this, the schools also analyzed the water quality with chemical indicators. Local water data collection sites were located into WGS84 (World Geodetic System 1984) coordinate system with GPS (Global Positioning System) receivers during the field research stage. These exact locations were visualized as points on digital maps together with the collected attribute data, containing the results of the biological and chemical water analyses. The attributes on the data tables were stored and connected by georelation with the geometric vector shapes on the map. The collection and creation of these local geoinformation databases was not the end itself but the means of creating the prerequisites for using GIS in the classrooms as an inquiry-based learning tool.

Figure 1. Mrs. Blandine Faucher, one of the French partner schoolteachers, is collecting BISEL data on water quality with her students in Herentals, Belgium. Photo: Tino Johansson, 2003.

GIS are modern tools for creating, managing, analysing and visualizing spatial information of any kind. The heart of these systems is software, which typically links the attribute data tables with a digital map platform. In GISAS project, the results of the water analysis were typed into attribute data tables where each row represented one map object, namely the water analysis sites which were visualized as points. The attribute data table contained columns where the variables from the analysis were typed. The students were able to create new columns and rows if the total number of water analysis sites increased or if new emerging variables were studied. With GIS the user can define the visibility and scale of each overlaid map layer on the platform as well as the visual outlook (symbols, colours and sizes) of map objects on each layer. The possibility to attach attribute data to every map object and to overlay many layers at once allows the user to make queries on the basis of the location or attributes of these spatially located objects. Queries may reveal interrelationships and dependencies between certain map elements and provide a tool for inquiry-based learning. These functions of desktop GIS software formed the basis of the exercises and activities carried out in the classrooms during the GISAS project.

In most partner schools, the water quality analyses indicated variation in water quality between different analysis sites. The next question in inquiry-based learning was to ask why there were differences between the analysis sites along the same river. The students worked in small groups and started to use the functions of desktop GIS software to find answers to this question. They collected and digitized more environmental data from the local environment and uploaded it into the GIS database as separate layers. They created databases on land use, wildlife habitats, pollutants, soil and open sewers. These databases were studied by overlaying and querying them for finding and selecting the variables, which best explain the variation in water quality along the studied river, for the final results. Next, they overlaid two or more layers and used the buffer tool to find out what kinds of elements were located within a certain radius from the deviant analysis sites. They continued the inquiry by making the potentially affecting natural and man-made objects visible and the insignificant elements invisible. As a result, they were able to study the location and attributes of the elements having an effect on water quality and to find out which element had the biggest effect on biological and chemical indicators of water quality there. The inquiry continued until they were all content with the found answers. In the end, the students produced a thematic map with the GIS software to document their findings for the whole class. GIS was primarily used as a tool for inquiry-based learning at the partner schools, allowing the students to study their local environment in a new way.

Objectives of the GISAS project

GISAS project was the first large scale project in Europe aiming to introduce and use professional GIS software as a learning tool at the secondary education level. There had previously been some smaller GIS education projects with much narrower focus and scope. Just like the early explorers sailing the unknown waters without knowing exactly what was waiting for them once or if they get to the destination at all, the GISAS project aimed high and set many objectives in the beginning of the project.

The objectives of the project were:

- Introduce Geographical Information Systems into European secondary and upper secondary schools
- Create a model on how to incorporate GIS into geography and environmental education at these educational levels
- Use GIS as a tool to enhance the study of local water quality in Europe
- Organize both hands-on and virtual in-service teacher training on GIS for the partner school teachers
- Create educational materials, exercises and a web-based learning environment for teachers and their students
- Test and develop these outputs in real-classroom situations with the help of partner school teachers
- Conduct research on the ways how GIS is used in secondary and upper secondary school education
- Develop and support international cooperation among teachers and students in web-based learning environment

The first three objectives listed above are far more extensive than the rest of our objectives. These higher order objectives can be partially achieved by reaching the lower order goals first. The lower order objectives can be achieved much easier within a limited amount of time and within a limited number of actors than the higher order objectives which require much more time than three years and a much larger audience, networks and institutional support to be achieved.

Our first objective was to introduce GIS into the secondary and upper secondary schools in Europe. Gerber (2001: 349) wrote that according to a group of international geography educators a series of directions, such as reconsideration of spatial understanding and its development, and technology and innovation, should be addressed in geography education in the coming decades. The mentioned directions all culminate in the use of GIS as a tool in geography education. One may wonder why these professional spatial analysis tools have to be introduced and used in secondary education in the first place. There are several rationales for this new trend of using GIS as an educational and research tool outside the universities, research centres and public administration. In our daily lives and activities, geographical information and more generally spatial information form one of the main pillars on which we reason our actions. Actually spatial information is so deeply grounded in our system of thinking that we seldom make a big number of it. Just think of an average autumn morning on your way to school, when it is dark, chilly and drizzling outside. Your first thought may have a spatial content, such as inside it is warm and dry but outside it is cold and wet, so what to wear on my way to school. The second spatial question in your mind may be the selection of the means of transportation to your destination. This decision may depend on many issues, such as distance, time, route and cost as well as weather. The bicycle could be the cheapest option, but you would get wet when you drive to school. It would also take more time and require a physical trial of strength if the school is located far away and if your route is mainly uphill. This simple example shows that we are processing geographical and spatial information on a daily basis. We have mental maps in our mind, where we have registered the location of many important objects and their attributes, namely the services and material or non-material goods and experiences we can found from these objects. Library, bank, church, school, theatre, hospital, park, restaurant are some examples of objects which we are familiar with and know their location and know what kind of service or activities can be carried out within those locations. In the Information Society more and more geographical and spatial information will be transformed into digital form and transferred to us as a part of the daily information flow. The consumers can study the bus routes and timetables with their web browsers and even get the arrival time of the next bus as an SMS message into their mobile phone. There are free web applications, which allow the user to see satellite images from distant places, zoom in to the city map and see the locations of hotels, restaurants, roads, metro stations and shops even in 3D-window. No longer are maps, satellite images or geographical information locked up into the libraries and offices but are widely available for all users having an access to the internet. Everyone is able to publish their own geographical information there too without any review or control of content reliability, accuracy and precision. The responsibility of using such information is shifted to the user. According to the European Commission (2006), the ability to judge the true merit of media content and make conscious choices becomes ever more essential for active citizenship and democracy. The Commission opened a public media literacy consultation in the beginning of October 2006, to study the public's views on media literacy. The media literacy skills include the ability to access, analyse and evaluate the power of images, sounds and messages and to be aware of this when making choices. Leat, Van der Schee and Vankan (2005: 328) mentioned that in modern information economy with rapidly changing technologies, continuous re-skilling will be essential but the current educational practices do not support such needs. Pupils' development as learners is as important as mastering knowledge and they are expected to be active and critical learners rather than passive recipients of knowledge. We believe that the educational use of geographical and spatial information with GIS at secondary and upper secondary schools allows the pupils to learn the basics of this information, including the abilities to create and access databases, analyse the available information and critically evaluate its content. In chapter two of this book, Dr. Lea Houtsonen from the Finnish National Board of Education gives an overview of the pedagogical viewpoints of incorporating GIS in the school curriculum. She emphasizes that the foundations of teaching GIS at secondary and upper secondary education level lay on constructivist principles. According to Houtsonen, teaching with GIS aims at promoting problem-based and inquiry-based learning, which were also in the pedagogical content of the GISAS project. Mrs. Ilta-Kanerva Kankaanrinta has carried out pedagogical research in the GISAS project and she discusses and gives suggestions on effective ways of learning and teaching GIS in chapter three. She used the partner school teachers' pedagogical diaries in studying which features of effective learning were present in GISAS project and discusses these findings on the basis of teaching-studying-learning paradigm.

Goodchild and Kemp (1990) stated over sixteen years ago that GIS should be introduced into the high schools for four basic reasons. First, the technology was becoming more common locally. Second, GIS is a valuable tool for environmental analysis and problem solving. Third, GIS enhances student interest in geography as well as in other subjects. Fourth, the use of GIS may motivate students towards careers in science and engineering. According to Timothy Keiper (1999: 49), this reasoning does not only apply to upper secondary schools but also to secondary and elementary schools. These early stated reasons provided the base for the GISAS project to introduce GIS into secondary and upper secondary education. It is important to point out that we had also one elementary school involved in the project, namely the Latvian partner school.

Bednarz and Van der Schee (2006: 192) mentioned that geography educators have justified GIS's introduction into secondary education using three rationales that correspond to its strengths. These rationales are:

1. the educative rationale (GIS support the teaching and learning geography)
2. the place-based rationale (GIS as a tool to study geographical problems at different scales)
3. the workplace rationale (GIS as an essential tool in the workplace in the 21st Century)

These rationales are complementary to the ones pointed out by Goodchild and Kemp. The first of the three rationales, namely the educative rationale, is the most debated one on the scientific literature. Meyer et al. (1999: 572-573) wrote that while the other warn that preoccupation with the mechanical use of GIS may distract from learning geography's analytical principles and theory, the others argue that using the visual components of GIS to teach spatial analysis can enhance learners spatial reasoning skills. "Teaching about GIS" and "teaching with GIS" are the two inseparable components of GIS education, originally introduced by Daniel Sui (1995: 579). He states that in terms of instructional focus, the debate centers on the issue of training versus education. Should the teachers focus on training students to use particular hardware and software or educate students about the geographical theories and concepts? The emphasis between these components can vary from one lecture and course to another, but at the introductory stage both must be present. In order to be able to teach with GIS, the partner school teachers first received training on the mechanical use of GIS software, so that they were able to use the basic functionalities and at the later stage add different thematic contents into the use of this technology. The GISAS project tried to avoid the techno-centric approach to learning and focus on the common educational theme instead, namely on the water quality of local rivers and canals.

The second rationale, which highlights the role of GIS as a tool to study geographical problems at different scales, suited well into the theoretical foundations and aims of the project. One of the objectives of the GISAS project was to collect various types of environmental data from the local areas of the partner schools. This data was used with GIS software to study, analyze, monitor and visualize local environmental elements, their effects on water quality and interrelationships, see figure 2.

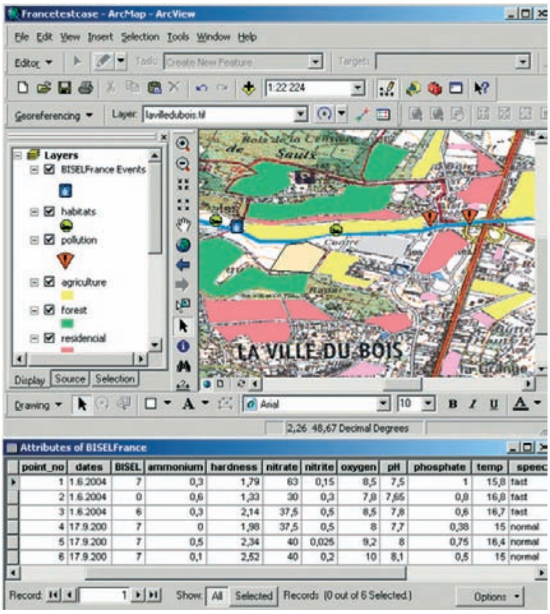

Figure 2. This ArcMap screen shows the idea of collecting data for different GIS databases and overlaying those on the map. The attribute data table shows the different water quality indicators collected by the French partner school. The vector shapefiles show the location of different land use types, sources of pollution, wildlife habitats, etc. on the map. ArcMap © is owned by the ESRI Inc. U.S.A.

The overlay –analyses of the collected data from different scales provided answers to the inquiries of the pupils and allowed them to actively combine different types of data layers and ask new geographical questions on that basis. The GIS tool allowed the teachers and students to seamlessly scale from water analysis sites to the local map where they could analyze the interrelationships of different objects based on location or attributes. They could easily extend their analysis by adding some extra databases covering the larger regional scales where available. Patterson et al. (2003) mentioned that the use of GIS in geography education developed students' spatial thinking skills and supported the overall geography teaching at the upper secondary school level. In GISAS project, all collected data was stored into a large database, where it is available for the teachers and their pupils to be used in the classrooms. Digital photographs taken from the water data collection points were hyperlinked to the points visualised on maps. The user may thus learn the water quality of a certain area and at the same time see the landscape image of that very area. Digital photos used together with the information from the digitized vector shapefiles and raster maps provided a lot of different information for the analyses. This enhanced the adoption of a holistic approach to environmental education and supported visual learning experiences. The recent EURYDICE (2006) report on Science Teaching in Schools in Europe, acknowledges the contribution of practical work to learning science and places importance on developing a holistic understanding of scientific activities and procedures, reflecting the approach of professional scientists. The report also points out that appropriate computer simulations enable the pupils to visualise theoretical models and provide a cognitive bridge between theory and practical experience and improves cognitive understanding. In the GISAS project, the national differences in raster map colours and geometrical shapes as well as different landscape photographs taken by the pupils for the database eventually allowed the schools to share part of their cultural differences in representing geographical information during the exercises and lessons. Local maps were also used for studying different coordinate systems and units.

The GISAS project used the ArcView 8.3. desktop GIS software of ESRI (Environmental Systems Research Institute) company. This software consisted of several programme components of which ArcMap and ArcCatalog were used during the project. The selection of the software for the use of GISAS project was based on several facts. ArcView is a professional GIS tool with hundreds of functionalities and it is relatively expensive for the schools to buy. It is one of the leading GIS software in the world and widely used by universities, research centres and businesses across the globe. The workplace justification now becomes clearly into surface. Since the software is in use around the world, there are many job opportunities available in different fields for those who learn to use it. Moreover, the pupils who will continue their studies at the higher educational level may already learn to use the same software at school, which they will probably use at the university too. We did not want to introduce open source GIS software for the schools because these often require some fluency in programming and are not often very stable. There were also some free GIS applications in the internet available in the late 2003, when we selected the ArcView software but their spatial analysis and drawing tools were quite limited and there were no local support in the partners' national languages for such products.

Figure 3. Mr. György Borián explains the functions of ArcView 8.3. software for the students in Barcs, Hungary. Photo: Zoltán Palotai 2005.

Some schools needed help in the installation of the software and then local ESRI dealers could help them. There was also a large selection of ready to use materials available for the ArcView software both locally and from the internet. We were aware of the fact that we would only use a limited number of the software's tools during the project. However, the project partners came from different educational levels and scientific backgrounds and also continued to use the software after the project ended so we wanted them to have GIS software, which would allow them to go deeper into the world of GIS and spatial analysis. Some of the partners worked with GIS in projects outside the normal curriculum and their students were also investing their free time to learn to use it. Even during the project, some partners had already started to collaborate with their local or regional authorities in using GIS for the community projects, such as locating the waste baskets of their town and building a database of it for improving the logistics. We found out in the project that it is essential to be able to work with real-world issues when using GIS in education. Local problem solving with spatial analyses provided real and useful results for the whole community, which added the value of the students work at school. Keiper (1999: 47) mentioned that using local data in the context of an authentic problem is one of the promising approaches of using GIS at the elementary level. The parents of the partner school students become interested in their work and the students felt proud when their outputs could be used by local authorities. Their work at school could really have a local impact. This could not have been achieved if the schools would have used a GIS tool with which they could only visualize some available databases from far away places. The use of professional GIS software made it possible for the teachers and their students to participate in the creation of GIS databases from the beginning, meaning that they could better understand how the precision and accuracy problems originated and how they could be solved. Another critical issue to think of when introducing GIS into secondary education is the use of the selected software in different subjects taught at school. Geography education gets relatively less emphasis in the secondary and upper secondary school curricula than the languages or history and biology, for example. Therefore the educational use of GIS should be cross-disciplinary and extend beyond the field of geography in order to be sustainable. The school administration may also prefer to fund equipment and software which can be used in multiple subjects instead of just one.

Each partner school in the GISAS project received funding for hardware, software, data and other equipment, such as GPS receivers and digital cameras. The project supported the integration of modern information and communication technology (ICT) into secondary education, not only in geography but in other subjects as well. The use of ICT and virtual learning environment allowed the schools to experiment, test and produce new functional, interdisciplinary and pedagogically appropriate teaching methods. GISAS project specialized in GIS but simultaneously paved way for the curriculum where the three intertwined learning domains, described by Hameyer (2002), come into focus. These domains are creativity (creative growth across the subjects), competence (explorative and gives space for intellectual freedom) and communication (share and work on ideas cooperatively).

Wanner and Kerski (1999) concluded in their study on the effectiveness of GIS technology and methods in the Boulder High School in Colorado, U.S.A. that implementing GIS in the curricula seemed to alter the manner of teaching and learning in the classroom. They noticed that teaching with GIS requires new educational methods, "such as posing real-world questions in a problem-solving, team-based, inquiry-based, open-ended environment, where the teacher is a facilitator of knowledge rather than a dispenser of it." Keiper (1999: 48) and Meyer et al. (1999: 572) emphasised that GIS instruction is mostly based on constructivist approaches to learning where knowledge is created by people and influenced by their personal experiences. Knowledge is created through interaction with the world. Also there will be a move beyond memorization to problem solving in the classrooms using GIS as a learning tool. Thus the GISAS project was not only about introducing GIS but also about introducing new approach to learning and teaching geography and more specifically learning about local environment and water quality. According to the technical report of the Institute for Prospective Technological Studies of the European Commission, edited by Punie et al. (2006: 18), educational systems are extremely difficult to change. Innovative learning and change (technological or methodological) are often against prevailing interests and existing institutional arrangements.

Introducing GIS into the curriculum of secondary schools is not an easy task. Bednarz and Van der Schee (2006: 197-199) emphasize that it takes considerable time and effort for any innovation to be implemented in education. They listed four external and some internal issues which influence teacher implementation of new educational practices. The integration of GIS into curricular guidelines will establish authority and power enforcing the teachers and schools to adopt the new practice. In addition to these two external issues, manageability and consistency has to be taken into consideration. GIS are rather complex in form and function, hard to handle and affect many aspects of teaching and learning systems, in other words, are not easily manageable and therefore slowly implemented. On the other hand, GIS can meet multiple educational goals and are consistent with other new influences in the educational system, which have a positive effect on its adoption. The internal issues, such as the persuasion of educators of the value of incorporation of GIS into the classroom, can be essential for the success of implementing new educational practices. Teachers' personal characteristics, prior knowledge and interests in the new practice clearly affect their interpretation of these innovations' added-value in the classroom.

We decided to start the introduction to the countries where our partner schools were located. The strategy was to use each partner school and the involved teachers as centres of spatial diffusion of innovation, meaning that the partner schools and teachers could use their existing school networks and communities to inform other schools and train other schoolteachers to use GIS in their counties and regions. Participating in national and international seminars and conferences allowed the partners to disseminate the outputs and activities into the neighbouring countries and even across the continent. However, the effect of this dissemination was much stronger and more successful in local and regional settings than in international forums. There were several reasons for that, such as lack of funding for the newcomers in the project, unavailability of materials and exercises in certain languages and lack of time for the diffusion of innovation in three-year project.

In the beginning of the project, at least two teachers from each partner school participated in the GISAS project activities. We wanted to ensure that there were enough teachers, who can teach with GIS in all partner schools during and after the project, in case some of the active teachers would be transferred to another school or retire. The teachers who participated in the project from the beginning could also learn to use GIS collaboratively and get support from one another. We learned that the teachers could also better negotiate with their headmasters and headmistresses about investing time and effort for learning and using the new GIS technology in the classroom and outside the normal curriculum when they represented the idea as a group. This is very important when introducing a new innovation to schools. According to Leat, Van der Schee and Vankan (2005: 329), the extensive review carried out by Black and Atkin in 1996 showed that attempts to bring new innovations into the curriculum depended on the key persons' abilities to "drive an innovation, culture and organization of schools, changing teachers' concepts of teaching and students' capabilities and teachers' anxiety about change." The participating teachers were not all from the field of geography but had a background from different subjects, such as physics, languages and computer science. This was not only a big challenge but also an important feature which enabled the project to test GIS as a cross-disciplinary tool in education. The GISAS project teachers were the key persons who disseminated and infiltrated the educational materials, exercises, new learning approach, project results and innovations at their own schools and provided training for their colleagues to use GIS in the classroom. Partner school teachers also cooperated with their municipal authorities and regional environmental agencies and at the same time tried to involve other schools from their countries as network partners for the project. We found out that creating contacts and networking with local environmental agencies and technical divisions of the town councils as well as support from local universities were crucial for the schools to establish the educational use of GIS on a sustainable basis on the local level. This is clearly indicated in chapters five, six, eight, ten and eleven of this book. This cooperation provided the schools a stabile source of GIS databases from the local and surrounding areas. It also established a link with a group of GI professional able to give lectures and training for the teachers and a chance to invite the students to visit their institutions to learn how GIS is used in their daily tasks. The local experts were also able to help the teachers in problems related to the use of GIS at school. We found out that introducing GIS into secondary and upper secondary school education could not be done in a vacuum but the process had to involve supporting institutions from the vicinity of schools. This way we were able to solve some serious problems in data availability, additional on-site training and support after the project was over.

In-service teacher training

The coordinating institution, namely the Department of Geography at the University of Helsinki in Finland was responsible of planning and implementing the meaningful training and learning model for the GISAS project. We knew from previous projects and experience that implementing GIS training for the in-service teachers and their students was not simply about converting traditional learning materials into computer and web-based training platforms. We were also sure that with a single approach or method we could not achieve maximum learning across a variety of learners within such a short period of time. We selected a blended learning approach, combining face-to-face instruction with computer-mediated instruction. Graham, Allen and Ure (2003: 6) described blended learning as "an instructional environment that combines a face-to-face instruction with distributed (or distance) instruction, enabling the instructor and learner to take advantage of both the hard and soft technologies most common in each instructional environment."

The GISAS project started to provide in-service teacher training in the beginning of the project. The partner school teachers received hands-on training on ArcView GIS software during the six project meetings. First, they received training on the theoretical background and structure of GIS, including the most important concepts and technical operations. Second, the hands-on training introduced the software itself and later they were trained to use the web GIS application created on the basis of their databases. They carried out monthly e-learning tasks on the basis of materials delivered through BSCW groupware. International collaboration played a key role in the GISAS project. The BSCW (Basic Support for Collaborative Work) groupware was used for discussions, asking questions and sharing documents, presentations and databases in zipped format. BSCW was also a platform for the educators to distribute training manuals, additional instructions for monthly homework and feedback for the learning process. The e-learning tasks were based on the illustrated user manuals, which explained the activities step-by-step for the teachers, see appendix 1. Each e-learning task produced a new database for the project and these databases were sent to the project manager for review through the BSCW also known as Bessie by the GISAS partners. The teachers were learning to use the ArcView GIS software with these exercises and manuals, which they could also use for carrying out the same exercises in the classroom with their students. The partner school teachers' were mostly content of the e-learning exercises and the materials. We found out that on-line training alone does not support the learning of GIS if the user does not have previous experience of using GIS software. Hands-on training sessions are essential for learning to use GIS and should be emphasized in the planning and implementation of teacher training seminars and courses. Before the end of the project the GIS exercise manuals were translated into the national languages of the schools so that these manuals were easier to use for teacher training and in the classrooms with the younger pupils. These illustrated manuals were also used outside the project consortium, for example, in teacher training on GIS in Switzerland. The language issue was very important or should I say critical for the project trying to diffuse the innovation into Europe. Teacher training was organized in English, making it relatively difficult for those teachers who were not geographers and not so fluent in English to follow the lessons. We had to avoid using too many GI concepts at once and tried to explain some concepts in a more popular way in the manuals and instructions. GISAS project operated in close cooperation with the pilot school teachers and placed emphasis on their feedback and needs in the creation and planning of the educational materials and outputs of the project. Sometimes this created delays in the work plan, especially when there were misunderstandings caused by the use of English language. The project web site http://www.edu.fi/gisas was translated into twelve European languages making it easier to inform new countries about our aims, products and processes. The translated exercise manuals can be studied and downloaded in Adobe .pdf-format from the same site too. The schools participated in testing and developing new educational GIS applications for the needs of secondary education. The cross-cultural group of schools from different countries and educational settings allowed the project to create an exemplary model on the incorporation of GIS into secondary education, which may later be extended to other countries. Hopefully the teachers and educational authorities across Europe find our approach and activities useful and try to replicate this model to introduce GIS into secondary and upper secondary education in their countries as well.

Web-based applications and dissemination of the project outputs

E-mails and BSCW groupware tool were the main forums for communication and material distribution among the GISAS project partners, but for the dissemination of the ideas, databases and exercises, the project established two web-based applications for the other schools in Europe to access these outputs. The partner schools participated in testing and developing an educational web-based water map http://gisas.ijs.si/, produced by the Jozef Stefan Institute in Ljubljana and Globalvision Ltd., Slovenia. This learning environment, see figure 4, allowed the partner schools to upload their local databases into the server for sharing the data and maps with the others in raster format so that different overlays were readily produced and the users are able to view

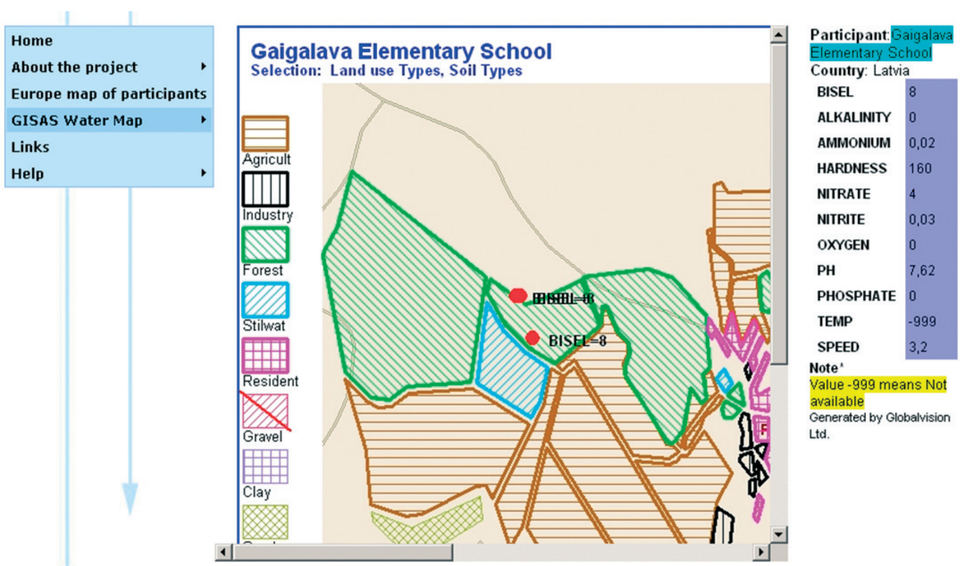

Figure 4. The Latvian case visualized in the GISAS water map, where the user can study the water quality of the selected points by clicking them with the mouse and by doing so, opens the attribute data from that specific site. There results can be discussed and compared, for example on the basis of the land use types found nearby.

the combination of different themes at once with their browser. The design, technical structure and implementation of this application is described in detail in chapter four by Mr. Bojan Močnik and Dr. Jože Rugelj. They also give suggestions for selecting the appropriate GIS software for similar projects and guidelines for data management.

This application is very simple to use and targeted for the users who do not have previous experience on GIS but are interested in water quality issues and in the GISAS project. The know-how and technical preconditions of using GIS in education differed a lot among the partner schools and teachers in Europe. The members of the GISAS consortium formed an ideal test case sample as their backgrounds, having representatives from nine countries and from various educational levels with different facilities, reflected quite well the general situation in Europe where the introduction of GIS takes place. The GISAS project also organized a videoconference to promote the understanding of GIS and outputs of the project into European teacher and student audience. Chapter five, written by Mrs. Manuella Borghs, gives more details of the videoconference. Availability of resources, hardware, software, databases and in-service training as well as time constraint (Bednarz and Audet 1999, Meyer et al. 1999, Baker 2001, Kerski 2001, Bednarz and Van der Schee 2006) are fundamental issues to take into consideration in incorporating GIS into secondary school education. Different curricula in the partner countries made the task even more difficult in GISAS project. Patrick Wiegand (2001:69) pointed out that in the United Kingdom the difficulty of obtaining appropriate maps and data sets was one of the biggest constraints for the teachers to introduce GIS into schools. He emphasized that "ready-to-use exemplars, which are central to the curriculum needs and from which teachers can develop their own applications as their experience builds, are urgently needed." Just like in the case of the UK, official information, such as digital maps of different scale and GI data sets are not freely available in Europe in general. Most topographic raster image maps and satellite images are the propriety of national land survey offices or the military and very expensive or impossible to get for the educational purposes. In the beginning of the GISAS project, this caused many problems for some partner schools because they could not get a raster map of their local area, which they could have use for the production of vector shapefiles. The importance of digital maps for the GISAS project is described in chapter four by Močnik and Rugelj. It is clear that the incorporation of GIS into the secondary education in Europe needs support from the national ministries and land surveyor offices or equivalent to secure the availability of digital maps for the schools. Without such supportive actions, the use of GIS will only focus on using maps and databases from the U.S.A. or some other distant areas and the local environmental education and inquiry-based learning initiatives will be seriously barred.

Keeping the above limitations in mind, the GISAS project started to utilize the local GIS databases which were created during the monthly exercises and were based on students' observations and analyses containing eight thematic map layers. These

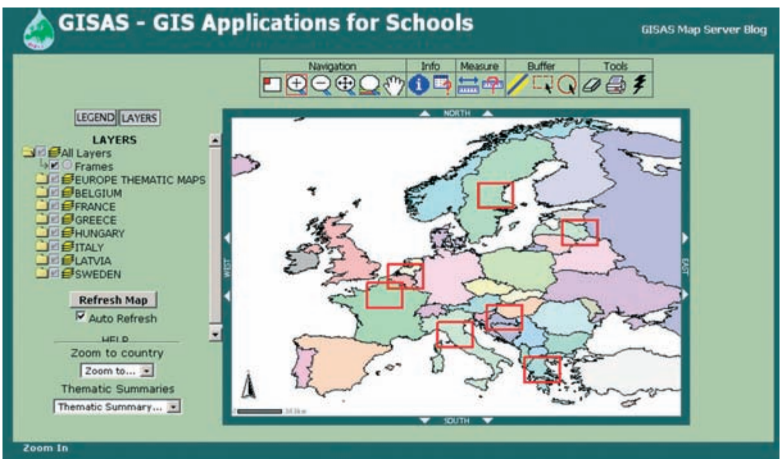

Figure 5. The interactive GISAS web atlas was created with ArcIMS software. It shows the databases in different scales from local (zoom into the squares) to European (countries). ArcIMS © ESRI Inc.

databases were first visualised and used with desktop GIS software at schools and then formed databases for an interactive web-based GISAS atlas created with ArcIMS (Arc Internet Map Server) software, see figure 5. There was no need to re-invent the wheel by using funds and resources for programming the interactive tools and web-based platforms ourselves because there were commercial software applications available. We decided to use the ArcIMS to make our databases and GIS tools already familiar from the classrooms available for all partners and other interested schools around the world through web browsers.

The web-based GISAS atlas allowed the partners to share their data with the other schools and provided educational materials from eight countries for inquiry-based learning. This served our goal to develop and support international cooperation among teachers and students in web-based learning environment. The learning activities with the web-based GISAS atlas did not only focus on geography and environmental education but the additional contents, such as digital photographs and local summaries, linked with map objects made it possible to study the results of the water analyses from other schools and critically reflect them and decide on further inquiry on the topic.

The creation of the web-based GISAS atlas also served the purpose of another objective of the project, which was to collect nation-wide water data for a European digital water atlas. This atlas is now part of the web-based GISAS atlas and contains nation-wide variables related to water quality, which are visualised as choropleth maps showing the differences between countries with changing tones of the colour slide. The user may choose from a list, which water topic is visualised on a European scale map and, as a result, may study the national differences. The map legend can be opened by clicking the Legend –button, see figure 6.

The flexible scaling of map windows and data from local to European scale map is one of the characteristics of GIS, which was used in GISAS project. The opening view of the web-based GISAS atlas highlights the European dimension of the project by showing the map of Europe and the location of project partners on that map as red squares. The educational idea of the atlas is that the users will first use it for studying the nutrients and organic matter content in the rivers on the European scale and then zoom in to the local scale where the collected BISEL and chemical analyses can be studied. By comparing the results from the two different scales, the users can make conclusions about the local situation, for example studying if the collected results are below or above national averages, see figure 7. The ArcIMS application also allows the use of different GIS tools, such as queries, buffers, info for studying the attribute data and measure tool for studying distances between map objects, just like the desktop ArcView GIS software does. This feature is very important for the project because it allowed the dissemination of ideas, educational materials, collected databases and tools outside the project consortium for all potential users. Any user may enter the ArcIMS application and use the data with web browsers. The URL of the ArcIMS application is http://hmaa05a01.geography.helsinki.fi/gisas/viewer.htm This way, the project ensures the dissemination of the interactive GIS tool for education

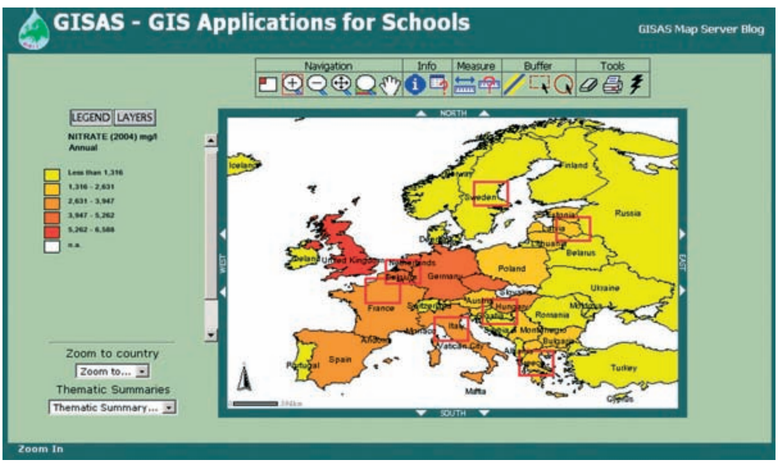

Figure 6. The users may first study the water quality theme on the European scale, for example by opening the choropleth map showing the mean annual nitrate (mg/l) content in the rivers in 2004.

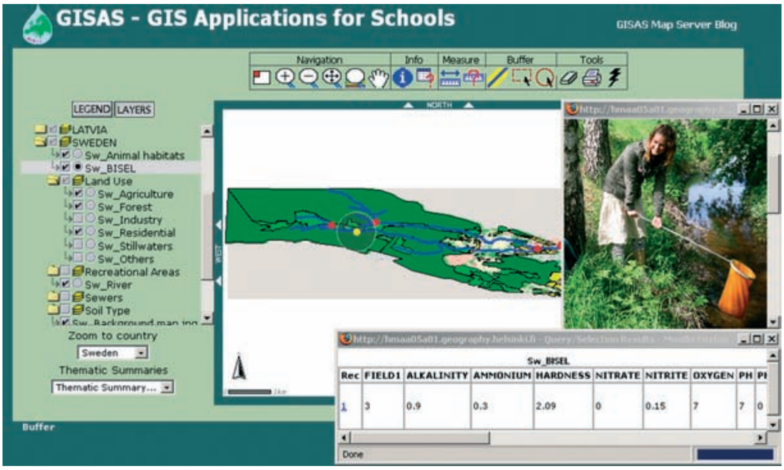

Figure 7. Local databases collected in the GISAS project allow the users to take the next step in their inquiry and learn the local results of the water quality analyses. Each analysis site has a hyperlink to a digital photo of that location, which can be opened by activating the layer on the list and then clicking the point with the flash tool from the above tool bar. The user can also use the buffer tool to study the land use within a certain radius of the selected location and learn which factors cause the difference in the analysis results.

and the project outputs across Europe and the rest of the world. Just before the end of the project, we also added GISAS Map Server Blog functionality on the application, so that the users may share experiences, ask questions and read the latest updates and news in a collaborative way. The BSCW was a closed learning environment for the project partners only, but the blog can be used by anyone.

The compiled descriptions of the analysis results can be also studied with ArcIMS by first visualising and activating a river line and then clicking the line shape on the map with the flash tool. Now a local summary opens and depending on the case, shows more photos, graphs and an explanation of the local water quality situation according to the results of the students' analyses. The thematic summaries are more general summaries having a focus on a larger scale and can be studied from the Thematic Summaries drop-down list on the left-hand side of the ArcIMS interface.

Conclusions

The know-how and technical preconditions of using GIS in education differed a lot among the partner schools and teachers in Europe. The importance of GIS in various sectors of the society is growing and there is also a growing need to include GIS as a tool into secondary education. Partner schools' feedback was mainly positive and optimistic and many new innovative ways to use GIS in schools surfaced during the project. The following chapters of this book, namely from chapter five to twelve, are written by the teachers' of GISAS partner schools. These chapters provide insight into the processes, exercises, dissemination of outputs and activities, challenges, obstacles and future plans of those teachers in using GIS in education as a result of the GISAS project. I will not go into the content of the chapters in detail here, but take out some of their findings which are important to sum up here as conclusions. A couple of teachers mentioned that a whole new world of teaching and learning was introduced to them and learning this approach and GIS tool opened up new ideas and projects in the classrooms, see for example chapters five, six and eight. Mrs. Manuella Borghs, writes about the enhancement of teachers' personal skills and the new cross-disciplinary collaboration at school, and as a result an institutional change in school caused by the project in chapter five. This is an outstanding example of the effects GIS education can have in the schools at best. Her findings can be used here to show that the use of GIS in education requires a reformulation of the existing teaching and learning approaches, which may be very difficult and time-consuming to achieve but certainly very fruitful for all participants when implemented. Mrs. Ineta Kruste and Anastasija Žukova describe in chapter seven, how they used and perceived GIS as a tool, which motivates the students to learn. They also found out that the combination of lab and field work supported students' critical thinking about their own work. They mentioned that their students found the representation of point objects with attributes on a map the most interesting exercise in using ArcView. I had a chance to train both teachers and students during the three-year project and it is easy to conclude that they all showed more interest in learning the map visualisation of their databases than building up the databases by typing attributes into the tables. The message for the educators interested in introducing GIS into secondary schools is to focus on practising with the GIS tools, which give an immediate visual output, such as vector images on the map. The younger the students are, the less patience they have for waiting their work with GIS to be visualized on screen as maps. Using too much time in building attribute data tables for map objects, can make the exercise boring for the students and create negative reactions towards learning with GIS in general. In chapter eight, Mr. Sandro Favini and Mrs. Cristina Negroni sum up that according to their experience, the use of GIS enhanced the environmental consciousness of their students. Their students were eager to carry out some extra GIS exercises on the local issues. The carrying out of these extra tasks was common to all partner schools, which clearly shows that they were very committed to the use of GIS and found it useful for different purposes which were not specified and required by the project. Mr. György Borián sums up the Hungarian experiences, in chapter nine, by writing that although learning to use GIS as an educational tool demands a lot of time, there will be an increasing demand for their use at schools in the future. He highlights that the complexity of GIS activities in their school has enabled the students to learn many things at once, which is very important. They could study the topic from the geographical, biological and historical points of view and at the same time learn English by using English ArcView software. The combination of computer-lab and fieldwork was also very fruitful for learning from his point of view. Here, I would like to quote the words of Mr. Antti Sierla, the Finnish Ambassador in Belgium. He was speaking at the press conference of the SM@K week in Geel in September 2006 and giving his opinions on the GISAS project. He said that it is obvious that "the GISAS project has used the help of computer technology and GIS to take the students back to the real nature to learn, which is quite the opposite of what computers are often blamed to do for learning."

Availability of resources, facilities and in-service training are fundamental issues in incorporating GIS into secondary school education. Lack of time was the biggest obstacle for the GISAS partner school teachers to introduce GIS into the classrooms. Several chapters of the book emphasize this. Other obstacles of the implementation of the project tasks and introducing GIS were lack of curriculum support, lack of computers, language problems, lack of digital maps and difficulty of the software. The last three obstacles were especially emphasized in chapter ten, written by Mrs. Georgia Kakardaki and Mr. Periklis Kamaris. Chapter eleven, written by Mr. Torbjörn Larsson, gives a detailed description of technical problems in introducing GIS to school. These two chapters are excellent cases, which show what kind of difficulties the schools face when aiming at introducing GIS into education. The background and facilities of these two partners are very different, the one with a background of geography and previous experience on GIS as well as high number of computers available; and the other without any experience on GIS and low number of computers available for the use of GIS. However, despite these limitations and obstacles, both chapters show positive prospects on using GIS as an educational tool in the schools. In Larisa, Greece, many teachers are eager to find ways to apply GIS in their subjects in the future. In Bollnäs, Sweden, new educational GIS projects and collaboration with their municipality in projects using GIS have already started; and as the labour pains of introducing GIS are gone they are able to build a firm basis for GIS use in education there. At the European level, different curricula in the partner countries will make the task even more difficult as there are no time for subjects outside the curricula. According to Rod Gerber (2001), who studied the situation of geography education in 32 countries around the world, there is considerable variation in the nature of geographical education. Eight of the nine partner countries of the GISAS project were studied in his research. Only Latvia was not present in the sample. Gerber noted that geography was still a largely mandatory subject at the lower secondary level, where particular emphasis is placed on the geography of local area and nation. At the upper secondary level, geography is taught mainly as a separate optional subject. He also pointed out that there is a decline in the number of students taking the subject in both Western and developing countries. The place of geography in the curriculum often defines the framework for the introduction of GIS into education. Despite the fact that GIS are cross-discipline educational tools, they are always perceived as geographical tools used only in geography. As Gerber's study indicated, the role of geography in the curricula of different countries has many variations from the lower secondary to upper secondary level in Europe. Like our partner school teachers have mentioned in their chapters, only in Belgium and in Sweden, where it is indirectly mentioned, GIS is part of the school curriculum. The Latvian and Italian partners mentioned that GIS is likely to be in their national curricula and such prospects could also be interpreted from the chapter of the French school. In the chapters of Hungarian and Greek schools, GIS was not even mentioned in the future plans for the curriculum. The total absence of geography from the curriculum of secondary or upper secondary levels in certain countries can severely constrain the efforts of introducing GIS into education in general. Moreover, the limited hours for geography and other science subjects in curricula make it difficult for the teachers to invest time for learning and teaching new educational innovations and technologies designed for these fields. However, it was found out during the project that GIS can be used for several purposes and subjects according to the teachers' needs and students' projects. There is a need to involve and train teachers from different fields of science and humanities to use GIS in the classroom. The experiences from the GISAS project indicate that a narrow focus on individual subject only does not give enough grounding for the introduction of GIS into secondary education. Introducing GIS as a cross-disciplinary tool can help the key persons to activate more interested teachers in their schools and convince the school board and administration to release more space and time in the curriculum for using GIS in the classrooms. If one takes a look into the labour market, GIS is used in many sectors of the society, from forest resource assessment and agriculture to archaeology and fire and rescue services, just to mention a few, so why these tools should only be confined to geography in the school curriculum. GIS can be used in visualizing and analysing spatially defined data of any kind. The GIS databases may contain different multimedia files making the learning even more interesting and visual.

The evaluation of the project has been carried out for the whole three-year period by the partners themselves and by the two external evaluators, professor Joseph Van der Schee from the Centre for Educational Training, Assessment and Research at the Free University of Amsterdam in the Netherlands and professor Gergely Horváth from the Institute of Geography at the Eötvös Loránd University in Budapest, Hungary. The observations and results of our external evaluators can be studied in chapter twelve, where they briefly summarize some of the key issues. The research results carried out during the project by the researchers of the University of Helsinki are not published in this book. Those results will be published in the forthcoming articles in scientific journals and publications.

A pilot project like GISAS cannot change the existing educational structures of the partner countries or make any decisions of introducing GIS into the national frame or curriculum. We have planted seven small GIS seeds into the partner schools across Europe. The seeds have been taken care of over there by teachers giving them enough care, water, nutrients and soil to grow. During the project, those GIS seeds have grown into saplings, spreading their roots into the neighbouring schools and requiring ever more attention, care, water, nutrients and space to grow into trees. Care requires time and workers; and space requires a curriculum allowing the GIS sapling to grow larger and have its roots spreading in the soil of several subjects. The project has given shelter and facilities for the seeds and the saplings for three years but now its support has ended and the saplings have to find their ways to stand the test of time and outside forces on their own. They have to compete for the nutrients, care and space with other saplings and reach for the light in the shadow of full grown trees around them. We sincerely hope that the foresters (educational authorities) find the content of this book useful and interesting and are able to use it for taking care of the GIS saplings by removing some of the shadowing trees nationally and allowing the GIS saplings to have more space and sun light for growth even at the international level across Europe.

This book is dedicated to the memory of Mr. Bojan Močnik.

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GIS in the school curriculum: pedagogical viewpoints

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Teaching in Geographical Information Systems (GIS) is nowadays provided in schools in many countries, since GIS education has close links with everyday life in connection with work or leisure-time activities. The status of GIS within the school curriculum varies greatly, however, and it is only in a few countries that such teaching is included in the framework for the national core curriculum for schools.

The aim of this paper is to discuss the significance of GIS teaching in schools for the education of citizens with an active interest in developing their own environment. The point of departure for this discussion will be the need for pedagogical development in the field of GIS teaching, in the light of the efforts made within the GISAS project to find means for achieving this. The teaching of GIS relies heavily on constructivist principles and is aimed at promoting problem-based and inquiry-based learning and critical thinking on the part of students.

Research has largely been concentrated on making use of GIS for scientific purposes and in various social spheres, and less emphasis has been placed on GIS research and development in education. It would indeed be important to study what pedagogical methods are best applicable to the teaching of GIS in schools.

Paikkatietojärjestelmien (GIS, Geographical Information Systems) opetusta on jo tarjolla monien maiden kouluissa, koska GIS liittyy läheisesti kansalaisten jokapäiväiseen elämään sekä työssä että vapaa-aikana. GIS-opetuksen asema koulujen opetussuunnitelmissa vaihtelee kuitenkin suuresti, ja GIS-opetus on otettu mukaan toistaiseksi vain harvojen maiden kansallisiin opetussuunnitelman perusteisiin.

Tässä artikkelissa käsitellään sitä, mikä merkitys koulun GIS-opetuksella on aktiivisten oman ympäristönsä kehittämiseen osallistuvien kansalaisten kasvattamisessa. Tarkastelun lähtökohtana on koulun GIS-opetuksen pedagogisen kehittämisen tarve, johon GISAS-hankkeessa on pyritty löytämään keinoja. GIS-opetus tukeutuu vahvasti konstruktivismin periaatteisiin ja edistää ongelmakeskeistä ja tutkivaa oppimista sekä oppilaiden kriittistä ajattelua.

Tutkimus on suurelta osin keskittynyt paikkatietojärjestelmien hyödyntämiseen tieteessä ja yhteiskuntaelämän eri alueilla. Vähemmälle on jäänyt paikkatietojärjestelmien opetuksen kehittäminen ja sen tutkimus. Tärkeää onkin tutkia sitä, minkälaisin pedagogisin keinoin voidaan parhaiten opettaa paikkatietojärjestelmiä kouluopetuksessa.

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Defining GIS and education in it

The development of technology is based on people's need to improve the quality of their lives at work and in their leisure time. ICT (information and communication technology) is part of the compulsory minimum curriculum for pupils virtually everywhere in Europe and also in many other parts of the world. Among the official aims of the curriculum, activities involving the use of software, information searches and communication networks for extending knowledge are uniformly the most widely represented in most European countries, irrespective of the level of compulsory education concerned. The learning environment must be equipped so as to support the pupil's development into a competent member of today's information society, and to provide opportunities for the use of computers, other forms of media technology and data networks. Computers are used least frequently in countries in which the number of pupils per computer is high. Teachers in primary and secondary education in most European countries have received basic training in the use of ICT for educational purposes during their initial teacher education, and the acquisition of ICT skills is encouraged in in-service teacher training in the majority of European countries. The development plan for teacher education drawn up by the Ministry of Education in Finland, for example, states that the pedagogical use of ICT must form a part of initial and further teacher training, and considerable effort has similarly been invested by many other European countries in developing the educational use of ICT in recent years (Eurydice 2004).

Teaching GIS forms a part of ICT education at various levels in the school system. A geographical information system (GIS) as such is usually defined as "a computer-based tool for mapping and analyzing things that exist and events that happen on the earth. GIS technology integrates common database operations, such as query and statistical analysis, with maps" (AmazonGIS 2003). Such systems are normally used for handling spatial information, which can be presented in several layers, each of which contains data on a specific parameter. Each item of attribute data is located by linking it to spatial data, usually expressed in the form of map coordinates.

Importance of GIS in education

Teaching in GIS is nowadays provided in schools in many countries, because of the system's close links with everyday life in connection with work or leisure-time activities. The status of GIS within the school curriculum varies greatly, however, and it is only in certain countries, such as Finland, that such teaching is included in the framework for the national core curriculum. Teaching in GIS should be provided in all upper secondary schools in Finland in connection with the elective specialization course in geography entitled "Regional studies" (Finnish National Board of Education 2004). According to the preamble to the national curriculum, the content of this GIS teaching should comprise the basics of geographical information systems and their applications and examples of the processing, interpretation and visualization of geographical source material within areas at different levels using GIS software. GIS teaching can be provided in connection with other subjects beside geography, however, e.g. history, biology or physical education.

Teaching in GIS serves well to support the general aims of a school education, and is among the "intercurricular themes" laid down in the preamble to the national core curriculum in Finland, i.e. themes that should be taken into account in the teaching of all subjects, being general educational challenges of significance to society at large which serve at the same time as statements of opinion on contemporary values. The goals that apply equally to all such themes include the abilities to observe and analyse current phenomena and functional environments, to put forward reasoned notions of the kind of future to be worked for, to evaluate one's own way of life, and to make choices and act in accordance with one's projected view of the future. These intercurricular themes are defined separately for compulsory schooling and the upper secondary school, although the results are largely similar, with some variations between the levels in the description of the goals and content. The themes laid down for the upper secondary level are (Finnish National Board of Education 2004: 26-31):

1. Active citizenship and entrepreneurship
2. Welfare and security
3. Sustainable development
4. Cultural identity and a knowledge of cultures
5. Technology and society
6. Communication and the media

The teaching of GIS in schools can be used to educate active citizens who have the skills necessary for participation in the information society, for work and for leisure-time use. It can also promote sustainable development and equip students to take part in planning and developing their own environment.

Green (2001) emphasizes that the increasing demand for virtual data and information on the environment, the adoption of IT and its importance within society mean that almost all citizens will need the ability to handle spatial data in the future, and he believes that the teaching of GIS will become an important part of environmental education in schools and a key area in our future teaching of geography. Teaching in GIS can develop students' logical thinking and problem-solving abilities, and by introducing GIS at an early stage it should be possible to develop a progression in learning about the use of spatial data and thereby lead interested students to study such matters at higher levels, including university courses. Increasing numbers of persons with GIS skills will be needed in various branches of industry and commerce in the future, and Green (2001: 44) proposes the following means for strengthening GIS teaching as a part of the school curriculum:

- raise teacher awareness through regular articles in geography journals about the use of GIS
- devise a school-level GIS curriculum
- initiate educational seminars, training sessions and meetings at local, regional and national levels
- develop co-operative links with local government, business and higher education for help with teaching materials, databases and software, and perhaps even hardware
- develop GIS teaching and resource packs, including databases, overlays, videos, reading materials, lists of contacts, and even a newsletter
- develop software to run on a variety of low-cost microcomputers to act as self-teaching tutors, demonstrations and practical sessions

Especially in the teaching of geography, the use of GIS can improve students' understanding of spatial concepts, although more research data is still needed on the question of how the increasing of spatial understanding by means of teaching in GIS differs from increasing it through the teaching of conventional cartography (cf. Bednarz 2004). The use of GIS in geography teaching precisely as a means of increasing spatial understanding can be justified on the grounds that geography as a science is devoted to the study of spatial order and spatial dependence relations and that its central concepts include spatial differentiation, landscape, environment (man – nature interactions), distributions, geometric features (networks), localization and the determination of location etc. Maps have traditionally been used to study spatial dependence relations and "overlay transparencies" are a classical method for identifying these.

Andersland (2004) has described how GIS can be implemented and used in the classroom. In a work aimed at developing methodological tools for use in education, he reports observations on the use of ArcView GIS and local aerial photographs, and concludes that GIS can be an exciting tool in education even at lower levels and that GIS technology can stimulate new methodologies for teaching and learning.

Chalmers (2004) notes that Web-enabled GIS mapping makes a new capacity available in the classroom and provides those who have access to GIS software in the classroom with the capacity to add to a data layer downloaded from the Internet. Chalmers concludes with the remark that the need for professional development in Internet-based mapping is a vital condition, because teachers have limited time for in-service training. He emphasizes that "sites developed with more thought provided teaching and learning frameworks and linked these to specific curriculum guidelines".

Of particular significance is the nature of the contribution that teaching in GIS can make to the development of pupils' critical faculties and their capabilities for analysis, synthesis and evaluation. Fitzpatrick and Maguire (2001: 70-71) see this as linked to the development of their logical-mathematical, linguistic, spatial and interpersonal intelligence, where "logical-mathematical intelligence includes numeracy and technological capacity, linguistic intelligence includes literacy and graphicacy, spatial intelligence includes map literacy and interpersonal intelligence focuses on communication".

Constructivism and the teaching of GIS in schools

Innovative teaching strategies such as Project-Based or Problem-Based Learning (PBL) require a diversity of tools for promoting learning (Bednarz 2001, 2004), and in the case of geography these include in particular applications of telecommunication and information technology that contribute to the management, analysis and visual presentation of spatial data, i.e. GIS. The teaching of skills in this field serves to support investigative learning as a whole, develops pupils' deductive capacities and helps them to understand the objects under investigation. GIS teaching leads pupils to make their own geographical observations instead of reading about those made by others and introduces them to many topics that lie at the very heart of geography. They can improve their cartographic skills, learn to interpret natural and cultural landscapes and attempt to perceive interaction relations between phenomena. GIS teaching also allows them to develop their skills in influencing decisions made within society and opens up opportunities for them to take an active part in developing their own community.

In this sense, GIS teaching is consistent with many of the central tenets of constructivism. The pupils are active processors of information who are engaged alongside other pupils, their teachers and their environment in handling and interpreting data reflecting situations in the real world on the basis of previously acquired cognitive structures. The notion of constructivism has indeed been regarded as having contributed to the incorporation of GIS into the school curriculum (Johansson & Kaivola 2004). Bednarz (1995), comparing the characteristics of GIS teaching with those of constructivism, has concluded that it leans very heavily on constructivist principles (Table 1).

Little research has yet been carried out into the pedagogy of GIS, and as Kerski (2003: 128) observes, it has mostly been "about GIS" rather than teaching "with GIS". It has nevertheless been seen in the existing literature that Web-based GIS applications for schools provide excellent opportunities, especially for young pupils, to collect and analyse geographical data and thereby increase their awareness of geographical phenomena (Baker: 2005). The pedagogical development of GIS and its teaching in schools is however one of the major challenges for geographical education at the present time (Houtsonen 2003: 57-58).

The teaching of GIS in schools is perhaps justified most of all on the grounds that it develops three aspects of pupils' spatial thinking: spatial visualization, spatial orientation and spatial relations. As relatively little research has been done in this field to date, it has been suggested in some papers on geographical education that we will have to wait and see whether advances in GIS technology will really help to develop pupils' graphical skills, and in particular their ability to recognize and interpret landscape features (Lambert & Balderstone, 2000, p. 212). Further information is needed, particularly on whether teaching in GIS promotes the development of spatial thinking more efficiently than does instruction in conventional cartography (Bednarz, 2001, 2004).

Definition of levels of GIS skills

The Research and Training Section of the Finnish GIS Advisory Board (2005) has defined a hierarchical set of levels of GIS skills such that all pupils at school should be able to achieve the basic level. Work on the standardization of skills has also be going on in other parts of Europe, too, having set out in the Netherlands, for instance, from a range of tasks to be performed using GIS, scrolling, visualization, analysis, generation of data, etc., each having its own particular requirements, while attempts have been made in Italy to define the skills to be required for a "GIS driving licence".

The aims of a general education may be regarded as including the ability to make use of everyday applications of geoinformatics and to adopt a critical attitude towards these. The scheme set out below comprises three steps in the acquisition of skills, by reference to which it is possible to evaluate students' levels of knowledge, the aim being to direct discussion towards the question of what should be the aims of GIS teaching in the upper secondary school (Finnish

Table 1. A comparision of GIS with constructivism (Source: Bednarz, S. 1995).

CHARACTERISTICS OF CONSTRUCTIVISM	CHARACTERISTICS OF GIS
Students construct knowledge.	Students construct knowledge through building databases or maps.
Students discover relationships through experience	Students explore spatial relationships through mapping.
Students learn in complex, authentic situations.	Students learn from real-world data and places.
Students manage their own learning.	Students guide themselves and identify relationships by exploring data.
The process of learning is as important as the product.	GIS is a tool to explore.

GIS Advisory Board, Research and Training Section 2005):

1. Basic level, at which students

a. are capable of critical evaluation of cartographic presentations appearing in the media.
b. are familiar with the basic concepts and understand what is meant by a GIS system.
c. are able to extract practical examples of locational data from their everyday surroundings
d. are able to describe with practical examples areas in which GIS could be applied within society
e. are able (critically) to make use of GIS services directed at the general public and understand the principles lying behind them
f. are able to interpret visualizations produced with digital GIS and synthesize the information they gain from this
g. understand the nature of GIS data as combinations of locations and attributes
h. understand that GIS data recorded for particular locations permit material from different sources to be combined
i. understand that attribute data for points on a map permit various analyses and visualizations to be performed

2. Advanced basic level of GIS skills, at which students

a. understand the principles of mapping and data acquisition and deficiencies in these
b. are familiar with the metadata concepts used in describing GIS data and the sources of such data
c. know how to make use of mobile GIS services and understand the principles behind them
d. are familiar with various ways of visualizing GIS data
e. are familiar with various ways of analysing GIS data and the areas in which these can be used
f. appreciate the differences between datasets produced on different scales and understand the importance of generalization

3. Advanced students

a. are able to visualize GIS materials in practise
b. are able the choose suitable GIS datasets for given purposes, understanding their differing descriptive techniques, scales, attributes, coordinates, etc.
c. are able to make use of simple GIS analyses and queries
d. know something of the history of GIS and understand current developmental trends
e. recognise and think up new everyday applications for GIS
f. are able to maintain and develop their GIS skills constantly

Barriers to implementation of the teaching of GIS

The barriers to more extensive implementation of the teaching of GIS as a part of the school curriculum would appear to be the same as those connected with the spread of ICT-based innovations in general in education. In his assessment of the latter in the light of his case-study research and a review of the literature, Dixon (2004: 119) mentions the following:

- insufficient computers available in geography classrooms to facilitate learning
- inequable access to a specialist ICT room
- variations in staff confidence and competence in using ICT as a teaching tool
- lengthy print queues at the end of the lesson, reducing teaching time
- ephemeral web sites
- technical hitches, causing frustration and, at times, abandonment of lessons
- lesson time wasted by pupils randomly surfing the net for information
- concerns that pupils were using the web to bypass learning by copying and pasting material or simply printing out the content of websites and presenting the output as "their work"
- a feeling that traditional teaching methodologies were less hassle and potentially more effective than using web learning
- ICT-based lessons required extra effort over and above "normal" preparation time

Current barriers to the development of the teaching of GIS in schools are said to include the lack of any mention of it in the school curriculum or the requirements of the Matriculation Examinations Board, the lack of GIS software and data packages suitable for use in schools, poor accessibility to computers during lesson time and the lack of supplementary courses in GIS for teachers (Wiegand 2001: 68; Johansson & Kaivola 2004: 204-208). One reason for the failure to undertake such development work has been seen to be a lack of awareness on the part of the educational authorities of the significance of GIS teaching for the upbringing of future citizens (Schleicher & Lawrence 2005: 86).

In the opinion of Wiegand (2001), one of the main factors preventing the adoption of GIS teaching in schools is the difficulty of finding digital maps and databases suitable for teaching purposes. In a survey among Finnish upper secondary school geography teachers, Johansson (2003) raised the issues of the lack of computers in classrooms, the lack of supplementary education in GIS for teachers and the shortage of software and teaching materials, while Kankaanrinta (2004) claimed that over 65% of Finnish geography teachers contacted were planning to adopt GIS applications for teaching purposes but only one fourth actually had experience of the use of GIS in schools.

Final remarks

Attention should be paid in school teaching to the rapid developments taking place in the field of GIS, as they impinge on citizens' everyday lives in so many ways, both at work and in leisure-time activities. The ability to use GIS services should be among the basic skills of members of the information society. GIS skills can support the education of active citizens, sustainable development and the communication and media skills required in the information society. Even pupils at the level of compulsory schooling should be able to gain an understanding of the nature of GIS, although teaching of its methods and the principles behind it is more challenging, as this requires new types of pedagogical solutions and also specialized teaching resources.

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Teaching and learning Geographical Information Systems effectively – reflections in teachers' pedagogical diaries

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The article discusses effective ways of learning in general and applies these principles to Geographical Information Systems (GIS) in schools. In the theoretical part the teaching-studying-learning paradigm and the general features of effective learning are described. According to meta research, effective learning is constructive, cumulative, self-regulated, goal-oriented, situated and collaborative. The features of effective learning are applied in GIS education with grass-root level examples from teachers' diaries in the GISAS project in 2003–2006. As a result, a handful of suggestions for effective ways of teaching and learning GIS are offered. These conclusions are connected to the emancipatory learning paradigm.

Artikkeli käsittelee paikkatiedon tehokasta opettamista ja oppimista. Aihetta käsitellään alussa teoreettisesti opetus-opiskelu-oppiminen –paradigman avulla. Opetuksen tutkimuskirjallisuudesta kuvataan metatutkimuksen osoittamat tehokkaan oppimisen keskeiset piirteet: konstruktiivisuus, kumulatiivisuus, itsesäädeltävyys, tavoitteellisuus, tilannesidonnaisuus ja yhteistoiminnallisuus. Näitä sovelletaan paikkatiedon opettamiseen ja esimerkkejä otetaan GISAS-projektin opettajien pedagogisista päiväkirjoista vuosilta 2003–2006. Yhteenvetona esitetään suosituksia paikkatiedon tehokkaaksi opetukseksi. Nämä periaatteet liitetään emansipatoriseen oppimisparadigmaan.

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Geographical Information Systems in school education

Geographical Information Systems (GIS) offer effective tools for analyzing places and regions, physical and human systems, as well as human-environmental interactions. GIS are applied in everyday life in many fields of society e.g. in logistics or public policy. So there is a pressure from society that schools should turn out people who already have at least basic knowledge and skills in GIS. And ever more employers wish to hire people who already can use GIS in creative ways. So GIS are a remarkable opportunity for geography education to apply strong and modern methods (e.g. Nellis 1994, Nellis 1995, Sui 1995, Bednarz 2004, Bednarz & Bednarz 2004). Simultaneously there is the problem of how to teach and learn these complicated applications in schools?

Discussions on teaching and learning GIS include a dichotomy of teaching with GIS and teaching about GIS going back to the time of Kemp & al. (1992) and Sui (1995). This means the choice is whether a central topic (with GIS) or the GIS technologies and skills themselves are more important (about GIS). Many authors like Kerski (2003), Bednarz (2004) and Baker (2005) have referred to the same point being unanimously in favour of learning with GIS.

The different views of learning with GIS and learning about GIS, however, are not necessarily contradictory but are complementary. It is hard to skip the technical aspect of GIS in schools at the very beginning of studies. Teachers and students need the plug and play techniques and lesson plans (e.g. Malone & al. 2002) in addition to the more general spheres described, for example, by Green (2001), Longley & al. (2001) or Alibrandi (2003).

Discussions of teaching about GIS or with GIS grow richer if a new point of view is added to them:

how to do this effectively. Because of the complexity and importance of GIS in society and in the school these considerations have strong relevancy. The aim of this article is to discuss the questions of teaching and learning GIS effectively. These considerations are based on a theoretical approach and on qualitative data from teachers' diaries in the GISAS project. As a summary a handful of conclusions are presented for establishing principles in teaching and learning GIS in schools.

Teachers' pedagogical diaries

Discussions between teachers are an important way to express thoughts and ideas about educational activities. Another way to process one's thoughts is to write them down explicitly during the process. So a teacher's pedagogical diary offers an opportunity for self-reflection during the project. Reflective pedagogical diaries, also called portfolios have long been applied among pre-service or in-service teacher education (e.g. Britten & Mullen 2003, Beck & al. 2005, Groom & Maunonen-Eskelinen 2006). Diaries are more or less informal literal documents that are guided by the tutor. The tutor may give the author some diary questions and tasks to be discussed in the diary. The questions are handled either together face-to-face or online or by e-mail. The diaries may include drawings, maps or pictures in addition to, or instead of, text. The thoughts can be stored in a notebook or in a file or e-mail messages. More and more diaries or portfolios are nowadays digital. They can be used as tools for assessment instead of an exam. In some countries such documents can also be of benefit in professional careers. They form a basis for individual teaching portfolio that can be edited afterwards for special purposes, e.g. for a certain application for an office.

The empirical data for this paper was collected in teachers' pedagogical diaries during the GISAS project in 2003–2006. The principles of diaries were explained to teachers in the first project meeting in 2003. The teachers were encouraged to write down facts and feelings like success, positive experiences, dreams (e.g. "Today I learned...", "It was wonderful to notice that..."); embarrassment ("I was so upset because…"; "I do not know how to...", "Students wondered why...") or loss, defeat and disappointment ("This was frustrating...", "Why isn't is possible to...?"). They could describe one event from the project or several events during the whole project. Because the project already included many activities, we used a light version of diaries and they were also optional for teachers. For this same reason they were not systematically tutored with only reminders of this option being offered every now and then during the project. As a result seven diaries from five countries were received at the end of the project. Because two diaries were prepared by a pair of teachers, the diaries presented the views of nine teachers. The diaries were mostly short, only a few pages. One diary was created with e-mail conversations between the teacher and the researcher. Teacher's diaries were analyzed focusing on the characteristics of effective learning (de Corte 1996, see next paragraphs).

Teaching, studying and learning – an interconnected process

The research literature of teaching and learning analyzes the basic components where one can build the ideas of teaching and learning of GIS. We apply here the common paradigm of teaching, studying and learning, also called the TSL-paradigm (Uljens (1997).

The teacher tries to influence the student's learning process by teaching. The teacher offers the materials, the method, the context and schedules for student activities in the classroom or in the field. But this does not necessarily imply learning which by its very nature is an internal and personal process of the student. Even if the teacher were the best in the world at applying GIS in education it does not follow that the student will learn if he or she is not willing. The influence of teaching on learning is indirect. When students use the resources and options offered by the teacher they can be said to be studying, but in the final analysis the actual learning is an internal and personal process inside students' brains. The teacher cannot influence these processes directly, only indirectly by teaching and helping the studying process. So teaching–studying–learning is a combination of linked processes between teacher and student. Each of the three components is equally important: what the teacher does, how the student utilizes the resources (studies) and how he or she assimilates new knowledge and skills (learns). Because teaching, studying and learning are linked with each other, it is possible to understand learning through teaching and vice versa. This principle is applied in GIS in this study.

Features of effective learning and ways of teaching

It is the eternal dream of teachers to help the students to learn effectively. Learning effectively may mean two things (Berger & al. 1994). Either the student can learn more in the same amount of time or he / she can learn the same amount in less time. Literature-based meta research summarizes six major characteristics of effective learning (de Corte 1996). Effective learning is constructive, cumulative, self-regulated, goal-oriented, situated and collaborative. Features of effective learning are interconnective with the ways of teaching that may facilitate them. In the next few paragraphs the features of effective learning are described at a general level and discussed in a GIS education context. Examples of teaching and learning GIS are given from teachers' diaries in the GISAS project.

Effective learning is constructive. That includes a strong personal view on learning. Students are no longer a bowl that is filled by the teacher. Instead, acquiring new knowledge and skills is always an active process on the part of the student. Effective learning is in principle a mindful activity full of effort even though the effort may be major for some students and minor for the others. The teacher can, nonetheless, influence student's learning only indirectly: offering materials, methods and schedules. It is ultimately the student herself or himself who is responsible for the learning. This means also that misconceptions of new facts or methods are possible. With these dangers in mind, continuous discussions between teachers and students within the process are necessary. If the teacher is aware of student capacities, it is easier to modify the teaching to be more supportive. This knowledge can be on a general level or about individual student differences. An example of general, theoretical knowledge is the theory of Multipple Intelligences by Howard Gardner (1995, 1999). According to it, instead of unitary and general intelligence, all human beings possess several intelligences. In an empirical study it was noticed that GISAS students who had spatial or logical-mathematical capacities or biophilia also succeed in learning GIS and environmental issues (Kankaanrinta & al. 2006). These results challenge teachers to know their students' capacities and strengthen such skills when applying GIS to environmental issues. – The teacher's diaries included several comments that could be interpreted as constructive learning. Teacher A wrote about "incredible discoveries" and the "autonomous learning" of GIS. Teacher F and Teacher G described their perplexities and uncertainties when teaching GIS. The negative aspect is only apparent because this mirrors a strong constructive learning process and the promises of progress waiting to reveal itself.

Cumulative learning means accommodating new ideas into prior knowledge. In order to be able to do that the teacher must know what the students already know about the content or the methods that are used. It would be better, therefore, for the teacher to discuss these issues with the students rather than just trying to guess things. The content is the easier component to check out and being a long-time teacher of the same students gives the teacher a good perspective on this question. Student experiences of GIS and ICTs in general are a more complex issue. Lots of applications of GIS are around us – they just need to be pointed out to the students. The teacher may, for example, begin with the telephone directory and proceed to examples of bus transportation or situation-based market research that is conducted before establishing a fast food shop. Prior knowledge of GIS may also be informal. Lots of popular computer games are based on GIS, for example traffic, urban, war or adventure simulations. So the students may be experts in certain kind of GIS applications without knowing this. It is also important that the teacher is aware of student's general skills in ICTs. It is hard to think of applying GIS without proper skills in system management, e.g. using folders or saving files. Prior knowledge may easily include misconceptions. These should be found out and clarified. It is necessary to use correct concepts of GIS from the very beginning. The teacher should carefully think about what the key concepts are that are used during the GIS course and how they follow each other from one lesson to the other. A glossary of concepts with careful definitions (in native language and in English) is necessary. – According to a teacher's diary, lack of prior knowledge was a problem at least for Teacher D in the GISAS project. Because geography or maps were not included in the school curriculum, the students did not possess any concepts or tools in order to build up the new knowledge of GIS. They just faced a new world of maps and geography without having any prior experience of it.

Still, according to Teacher D, after the first surprise the students enjoyed drawing lines and polygons with GIS. This shows how creative and flexible students are in constructing new knowledge in their minds. It also shows the educational skills of teachers in introducing a new world to their students.

Self-regulated learning refers to the learner's ability to manage the learning situation herself or himself. The student controls the pace and the sequence of the learning and also consciously offers feedback on her/his activities. The motivation is intrinsic. The increase of learning motivation with GIS has been recognized in students (Baker & White 2003, Bednarz 2004) and in teachers (Kerski 2003). – In fact the need for students' self-regulation was noticed in many informal discussions with the GISAS partners during the project. It was also clearly expressed in Teachers' F and G diary where they explained how to apply GIS in the field and in the classroom and what the final part consisted of: "Last but not least, we would have a general discussion, and the students would be encouraged to suggest what else, in their opinion, could be done with an tool like GIS, and what other subjects could be involved in such an innovative teaching methodology." Teacher E gave another example of the self-regulation in the diary. Student water quality measurement results indicated that the water quality was good. This was contrary to what was the general opinion in the city. Teacher and students suggested several explanations for the result, discussed it with local experts and finally concluded that more samples are necessary in order to quantify the purity of the water. That is an auto-regulated quality control of the work. It is also an example of constructive thinking processes. Teacher A expressed power of self-regulation: "Mistakes are 2 learn from. … Self confidence, peer teaching and coaching, students becoming self-made specialists."

Effective learning is goal-oriented which is also called intentional. Using GIS in education always includes the goal of learning something like skills, knowledge, methods or ways of thinking or attitudes. The goals should be a result of common negotiations between teacher and students, the teacher cannot express the goals as an authoritarian decision which would destroy the principle of self-regulation described above. However, the teacher or a book or a computer program can offer draft proposals for objectives where the students have an option of modifying them. A cumulative set of learning objectives in GIS is described, for example, in the book of Longley & al. (2001). Goals may be set within a certain lesson and for an entire course. The longer the timeline is the more general are the goals. Short term goals are often on a concrete level, detailed, perhaps technical and about GIS. Long time goals are more often on an abstract level, more general and with GIS. A teacher can easily find arguments for offering GIS goals for students: they include interesting and challenging activities with ICTs, opportunities for useful skills that may lead to good jobs, and a new understanding of the world and phenomena as a set of layers, a new way of thinking and solving problems. With optimal goals the student may be completely immersed in what he or she is doing, with enjoyment and fulfillment. The talents of the performer and the challenges of the task are in balance resulting in the flow experience (Csikszentmihalyi & Csikszentmihalyi 1992). – In teacher A's diary a note is made how goals may be simultaneously high and reasonable: "Goals are reachable, the sky is the limit, secrets are revealed", or "@mbitions, never too much".

Situated learning implies that learning should be anchored in real life situations. The physical and social context should be authentic and mimicry used as much as possible. GIS and maps can be applied in any school subject: e.g. music or athletics or social sciences can be presented with maps. In Europe, lots of GIS are used in environmental science or biology. So geography is not an obligatory partner for GIS, even though some may say that any subject evolves into geography when a map is used. More examples of applying GIS can be found on the Internet, e.g. applications in clearing up crimes, logistics and regional planning. However, there are also students with creative capacities who are not interested in practical applications, but ideas or inventions (Papert 2000). Also they need opportunities for situated learning, meaning this time learning in their minds, in their own personal ways. – Teacher H and Teacher I gave an example of situated learning in a hypothetical GIS lesson on urban geography. Students could determine architectural sites in the city by GPS and create an interactive map for tourism purposes. One partner in the GISAS project applied GIS in cooperation with the technical department of the local municipality with the students locating paper baskets with GPS. Also Teacher A and Teacher B mentioned in their diaries applying GIS in real life situations with local administrators.

Effective learning is collaborative. This is not in contradiction to the individual aspect of learning. Learning is both a social and personal process. For example, in conversations students learn to express their thoughts, argue their views and question the views of others. In addition to oral or literal means students can use visuals aids and representations. Cooperation may be horizontal, within students in the same classroom and within teachers in the same school. As we already have seen it can also spread outside the school to local authorities or partner schools. The positive influence of cooperative discussions during GIS lessons have already been noticed in Wiegand's research (2003). On a general level, cooperation has proved to have a crucial role when studying with ICTs (Jonassen 1995, Johnson & Johnson 1996). – According to teachers' diaries versatile forms of cooperation were frequent in the GISAS project and it was mentioned most often of the characteristics of effective learning. For instance Teacher A emphasized in the diary how "knowledge goes from student to student". In addition to the international character of the GISAS project itself, all the teachers involved also had other international activities going on. Some of them also disseminated their experiences in the project internationally in congresses and formed new contacts with teachers and GIS experts. Teacher C wrote in the diary: "I have met so many interesting people on local, national, European and international levels and I have learnt a lot." Lack of sufficient cooperation between colleagues at school was frustrating for Teacher B, Teacher F and Teacher G. When the work was with such complicated issues as GIS applied to environmental phenomena, it soon became clear that cooperation with geography, science, biology, chemistry, physics and English teachers would be necessary, they stated.

How can teachers facilitate the effective learning of GIS?

We can summarize the general features of effective learning and offer some suggestions on how teachers can apply this in GIS education.

First, the teacher offers the students opportunities for constructive learning of GIS. The teacher has diverse materials, methods and schedules for the students to choose from. So the student can create an individual process of studying and learning. The tasks include challenges and feed the curiosity and imagination of students with different capacities. Teacher and students show patience together albeit with occasional confusion or uncertainty, perhaps proof that an intensive learning process is going on. The students are encouraged to take responsibility for their learning.

Second, learning of GIS is rendered cumulative. Students' prior knowledge of content, of ICTs and of GIS applications like simulation games are checked. Misconceptions are discovered and explained. The teacher is careful with concepts and demands the students to be careful as well. A glossary of concepts is collected in the national language and also in English (the language of the software), if necessary.

Third, self-regulation of learning is permitted. Students have control on the pace and sequence of the learning, whenever possible. They are stimulated to consciously think what they are doing and why they are doing it. Even occasional idleness may be a normal phase in the creative process. Students are encouraged to feel free of fear of mistakes – instead mistakes are seen as a resource of learning.

Fourth, learning has short-term and long-term goals. Reasonable goals are placed together with students. Each student may have individual objectives and they can be modified during the process. The evaluation of the process and products is in relation to the objectives. The teacher and the students try to find out their capacities in order to strive for an equilibrium between tasks and performance which may lead to an optimal experience which is also called flow.

Fifth, learning is situated in a real life context. Authentic problems, tasks and materials are used as much as possible. Excursions to companies or associations that use GIS in various connections are used. Diverse experts of GIS outside the school are used. Teachers should apply GIS in creative ways, in various subjects and contexts. They also accept that some students may be more interested in impulsive inventive applications than in more practical applications.

Sixth, learning is based on collaboration. Collaboration is encouraged inside the class, inside the school and outside the school, nationally and internationally, see figure 1. Collaboration includes diverse actors like experts in GIS, experts in content and scholars of teaching and learning. However, also students who want to work individually are accepted because of the constructive character of the learning process.

Figure 1. Collaboration in constructing new knowledge in the field. Swedish partners practise the use of GPS equipment. Photo: Sirkka Staff 2004.
Kuva 1. Uutta tietoa konstruoidaan yhteistoiminnallisesti kenttäoloissa. Projektin ruotsalaiset partnerit harjoittelevat GPS-laitteen käyttöä. Kuva: Sirkka Staff 2004.

Effective learning of GIS and empowerment

In general, the features of learning GIS effectively reflect the emancipatory learning paradigm. It is based on the emancipatory view of knowledge (Habermas 1965/1978) which means liberating individuals from the norms of a deterministic existence and aims at a mature and balanced society. According to the emancipatory learning paradigm students are active in the learning process, teachers are facilitators, tutors and organisers, communication is open, frequent and versatile between the participants and school is openly connected to society. Students are empowered to take control over the learning process. Also teachers are empowered by the freedom to make their own educational decisions and to develop professionally.

The empowerment of the teacher was clearly expressed in the diary of Teacher C: "GIS gives us the possibility to know, to create, to publish, then to communicate with others… . The educative network has not only to be in the hands of technologists, but also in the hands of the citizens to create one Europe. GIS is creative. When we have to create, it is our responsibility, we take the responsibility. We are nearer to one another, if we are in the same network. … I feel I am in the new moving wave on a professional level but also on an individual level, even if GIS has for me many, many secrets.… I have had the chance in GISAS to explore that I like to work on different levels, education, training, research, with different partners of different countries. It means the European adventure together in education."

The emancipatory learning paradigm challenges the old instructional paradigm where the student is seen as an empty bowl that should be filled with knowledge from the teacher. Instead, the teachers' task is to rouse a fire, a passion in active learning, exploring new knowledge and skills. New technologies cannot be applied to old routines in schools because this destroys the potential involved in these innovations (Papert 2000). Teaching and learning GIS effectively, according to the emancipatory learning paradigm opens their potential to students as well as to teachers.

Opportunities for teachers' pedagogical diaries

Teachers wrote in the diaries mainly how they applied GIS in environmental issues. So they discussed teaching and learning with GIS, the context-based point of view. There were only few thoughts given to technical details, about GIS. Teacher B wrote about shapefiles and finalizing the maps after the students. Teacher A described the experiences of patiently persisting in making buffers, creating layers, drawing lines and dots. Focusing on content in the diaries does not mean that technical issues had a minor role in the project but they were handled in other connections. Basically, this proves that teacher's diaries are more appropriate to discussing teaching with GIS.

Teachers are in a crucial role in applying GIS in schools. It was noticed in teacher's pedagogical diaries in GISAS project that teachers already applied many effective ways of teaching. In future development projects teachers could be helped more in finding such things and in applying them. Research-based suggestions and questions could be offered at opportune moments. Explaining one's ideas in the diaries in words, drawings or other representations helps in finding the key points. Cooperation with a peer tutor helps to develop the ideas further. So the pedagogical diaries could serve as tools in the teaching-learning process. In addition to literal means (e-mail, groupware and chat), this kind of reflection could spread outside the diary through various forms of communication like Skype calls, videoconferencing and netmeeting.

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Web application and GIS resources

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The GISAS project which is carried out in the framework of the European Socrates-Minerva action program is a strategic pilot project in the field of active introduction of information technology in the education process of European secondary schools. The main aim of the project is to find the methodology for effective incorporation of IT into teaching and learning. The role of the Jozef Stefan Institute was to design and implement the web application for visualization and sharing of data, collected by participating schools, and to provide technical support for the project. The GISAS web application (web atlas) was supposed to be a web-server with simple user interface for uploading "water maps" with data about different characteristics of rivers from the neighbourhood of partners' schools.
Students from the participating schools learned by participation in project activities how to collect data in the fieldwork, how to store and visualize them by means of selected GIS tool, and how to publish on the web atlas, and thus share, produced maps by other partners and all other interested parties.
The experiences collected in the project made evident that it is not enough just to set up all above mentioned infrastructure. A lot of efforts were needed to set up common understanding of basic notions and conceptions by all the partners, to define data model and to harmonize the maps. Our experiences can be useful for all similar projects in the future.

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The web application design

The main project task was introduction of GIS technology into European secondary schools. For that reason the decision was made to design a web application which will be able to present standard web contents along with GIS products as digital maps, thematic vectorised data layers and the combinations of various layers. We planned that at the end of the project each participating school will have access to all the material produced by other partners the in project.

Already in the beginning of the project coordination consortium has chosen the ESRI's Arcview and ArcGIS package as the official project GIS software tool used to carry out the tasks related geographical data. Selection of a GIS tool was a basis for all other decisions concerning web atlas application. It had to be designed in such a way that the products of the ArcGIS package, which is used by partner schools to carry most of the project tasks, could be imported into the web application and presented in the World Wide Web in a suitable form.

Since GISAS project is water related and "water data" were collected by the partner schools with different methods, we needed to design and define data model and the processes for data collection in the application. Such standards are the only way to avoid chaos when data from different sources are collected and stored under the same roof.

The data collected by the partner schools during the fieldwork were primarily entered on the maps by the ArcView tool which provides all the necessary functionally to insert, edit, label, sort and visualize data.

After collected field data is properly processed in ArcView, it is prepared to be exported in a format which is suitable and supported by the GISAS web application for publication on the web.

The ArcView – GISAS web atlas communication channel was defined through the standard ArcView output files: shape file (.shp) as a file describing vectorized geographical data and numeric database file (.dbf).

Shape file (.shp) is a data structure developed by ESRI for ArcView GIS software package used from the early 1990's. Shape format has been openly published by ESRI and is widely used for data interchange in GIS. Shape files are easier and faster to draw and can be edited. Shape files are composed of at least three files: *.shp (stores the feature geometry), *.shx (stores the index coordinates to the geometry) and *.dbf (dBASE file that stores the attribute information of features). Additionally, you may see several other files with the same file name such as *.sbn and *.sbx (spatial indexes), *.prj (stores the projection and date of the shape file – very good to have when exchanging the data or using with a GPS such as ArcPAD).

Database file (.dbf) is a numeric data file structured as a table of map attributes and their values. ArcView and ArcGIS store their data in DBase format, a fairly common file type for databases. These types of files have an extension of .dbf, and can be read by various applications (as well as Microsoft Excel). Every attribute has a specific data type (string, integer, real…) and a specific range of values. Different values or value intervals has a specific representation visible from a map legend.

The collected data is finally uploaded on the web with data tables and graphically as a collection of the schools' local maps with eight different layers of data. Internet services provide us with simple and easy means for distribution of data among partner schools. Besides that they are free of charge for educational purposes and they can also be used for presenting the project and its results with new technologies to all interested parties.

Resources for effective project execution

Software

Many different resources are needed to run educational GIS project effectively and efficiently. Specialized geographic software package is needed for entering and processing geographical data. Many different GIS companies are present on the world market with their software packages. All these software are quite similar in the essence, as the expectations about their functionality are similar. All of them are supposed to support importation of digital maps, operations on the maps (e.g. finding objects, measuring distances), adding new data, performing simplified queries about the data, editing and updating the data, as well as presenting data numerically and graphically.

Nevertheless we can distinguish between two major groups of GIS software tools: professional software packages with sophisticated user interfaces and extensive functionalities and simplified, more user friendly software with basic functionality.

The decision about which to choose lies on user and depends on his recognition of his own needs and demands, on his skills and experiences in this field and on his goals and motivation in a GIS project.

The professional software packages offer numberless functions and options, more detailed user interface, complicated menu systems, maybe they provide permanent user support and as a rule they are expensive. On the other hand less sophisticated software packages cost less, supports only the most obvious and most frequently used GIS functionalities, and they are easier to handle for novice and inexperienced users.

In the GISAS project, a decision was made to use the professional ArcView GIS tool. It turned out during project activities that most of the participants, who were mainly inexperienced with GIS tool, found such a professional tool quite difficult to comprehend. As a consequence, a lot of time at the workshops was spent to learn how to deal with the tool instead of focusing on the contents of the project and to didactical aspects of its use in the classroom.

As teachers and students in secondary schools are the target groups of the project, it would wise to reconsider this issue and to select less demanding but still functional GIS tool. Teachers are quite limited as regards the time inside the curricula they can spend on this topic.

Digital maps

Digital map is one of the basic resources used in a GIS project. In our project it was a digital map of municipality where partner's school is located. It turned out, surprisingly, that getting a digital map was not as simple as we might anticipate. Supplying adequate digital map opened up many different issues. Partner schools had to find:

- the competent institution which produces digital maps,
- appropriate type of the map (map scale, digital formats of maps).

Also prices of digital maps caused some problems. While digital maps were publicly available and free of charge in some countries, in other countries schools have to pay for them and in one case the detailed digital maps were in a competence of the army and not available for the project.

The next obstacle was publication of digital maps on the web. Most of the countries allow usage of digital maps after some fee is paid, but this usually does not cover a public publishing of a map. For that reasons the partner schools needed to pay an extra fee or apply for a public publishing license. The consequence of all these unexpected problems was that a lot of time was spent for harmonization among all project partners with a lot of efforts from the coordinator. As a digital map in GIS project is one of the crucial artefacts in the learning process, all further tasks and actions were delayed.

The result of joint efforts of all partners involved was that all digital maps were obtained, but the problem of map diversity from country to country was still not completely resolved.

The data

The GIS concept integrates four main elements: hardware, software, data and users. Each part is vital and a system can not operate without all four elements connected with each other in a whole.

Digital maps are an integral part of the wider term of data in GIS systems. The narrower meanings of data are pieces of data that we use in the GIS software database. Those data are really the attributes of the phenomena in the real world we decided to explore within a GIS project.

The main thread of the GISAS project was to determine the water quality of a river or creek in the neighbourhood of each partner school and observing its basin. Multiple layers were defined in the project. Each layer covers selected attribute of the river or its basin (BISEL water index, land use, industry, pollution sources, recreational areas, animal life, etc.). Comprehensive and interesting analyses can be made when the layers are studied interdependently in the GISAS web application.

A large amount of data in GIS system is an advantage, but it requires careful and sophisticated manipulation to prevent chaos. GIS solves this problem with its software that deals with data stored in databases. GIS software might be quite complex and not easy to use without any experience.

Collecting data from so many different sources, from different countries, finding data in different formats and of various qualities always presents delicate and difficult problem in informatics. Solving those problems requires at least a basic knowledge of informatics, data models, data structures, and data types, as well as some basics on management of databases (e.g. data tables, attributes, attributes names, data ranges, …) Poor data handling, misunderstanding of data models, and different interpretations of data model lead to confusion and consequently to further delays in the project.

The partners responsible for this part of the project finally succeeded to define a data model that was acceptable for all the partners and on the other side simple and effective enough to handle all the data collected by partners.

Teacher training

The fourth of the GIS resources that keeps system alive are users. In our case users are teachers and students.

Getting familiar with hardware, GIS software tools, and with new didactic approaches are only the most essential new skills and knowledge that geography teacher should gain when GIS and its applications are integrated in a curriculum. Only in this way a teacher can effectively use all advantages of GIS and can offer his students quality lessons.

Specialized GIS software is commercially widely available and some producers of this software offer special, lower prices for the educational institutions. Some of them are highly interested to popularize their GIS software tools and they offer help and assistance for purchasing and installation as well as lifelong support for their product. It is always very useful to have a few hours of free support with GIS software as well as with the usage of specialized hardware (e.g. GPS receiver).

Besides the above mentioned additional education for teachers, we have to mention also a problem of complementary didactical approaches. As we were informed by the teachers from partner schools, many institutions for teacher education still use traditional frontal method of teaching and only in some countries student teachers get in touch with other alternative ways of teaching (e.g. problem oriented teaching, integrated teaching). A step to the right direction would be more systematic integration of such alternative teaching methods to the universities and other institutions for teacher education. Use of new technologies in education, such as ICT in general (and GIS as a special case of ICT) can not be integrated successfully into such traditional teaching models as they require active students and student centred approaches.

Conclusion

Many unforeseen problems appear in pilot projects and a lot of knowledge, experience, motivation and good will of all participants in the projects are needed to solve the problems and to overcome the obstacles. The motivation of all partners to participate in the GISAS project was high because of its original concept and stimulating coordination. Also the motivation of all students who participated in the pilot project was good. These facts confirm that the ideas about the integration of GIS into schools are correct. Traditionally poor cooperation between universities and secondary schools can not improve overnight, but this project clearly manifests the need for more intensive partnership in the future.

We believe that the results of the project and experiences gathered by of all participating teachers and students will be a reference and significant source for future activities in this field.

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Figure 1. Mr. Bojan Močnik and Dr. Jože Rugelj are comparing the GPS coordinates with the Greek teachers in Helsinki. Photo: Solveig Bergsten 2004.

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Fellowship of a project

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KOGEKA & GISAS: a sm@k experience!

Thanks to the GISAS pilot project, KOGEKA has become a trendsetter in GIS oriented geography education and innovative learning. Our school community installed the ArcView software and trained the geography teachers to implement GIS in their daily lessons. Conform to our pedagogical project, we offer our students the possibility to practise their scientific and ICT skills in a situation based on real life and to follow innovative educational learning paths. KOGEKA wants to spread this experience and stimulate secondary schools and teacher training schools to follow this example. The new curriculum for geography lessons in Flanders, which became operational in September 2006, mentions Geographical Information Systems (GIS) for the first time as a compulsory component of the program of the third degree (15 to 18- year-olds), wishing to make pupils familiar with GIS. We hope of course that other schools will also benefit from our experiences. Although most of the GIS applications proposed are specifically for the science directions and most of them are optional, KOGEKA aims to motivate schools to implement GIS into their lessons.

Dankzij het piloot project GISAS is KOGEKA nu voorloper in GIS gebaseerd en innovatief leren tijdens de aardrijkskunde lessen. Onze scholengemeenschap heeft de Arcview software geïnstalleerd en aardrijkskunde leerkrachten opgeleid om GIS te gebruiken in hun lessen. Zoals vermeld in ons pedagogisch project geven we de leerlingen de mogelijkheid hun wetenschappelijke en informatica kennis te toetsen aan de realiteit en ze toe te passen in reële casussen. Dit doen ze door op een nieuwe manier te leren en te werken, via innovatieve opvoedkundige krachtige leeromgevingen. KOGEKA wil deze ervaring verspreiden en secundaire scholen en ook de lerarenopleidingen stimuleren hun voorbeeld te volgen. Vooral nu kunnen scholen voordeel halen uit onze ervaring. Immers, sinds september 2006 staat GIS educatie expliciet vermeld in de leerplannen aardrijkskunde voor de derde graad. De Vlaamse overheid wil dus ook de Vlaamse leerlingen vertrouwd maken met het gebruik van GIS toepassingen in de lessen aardrijkskunde. Hoewel de meeste GIS leerdoelen nog optioneel zijn en vooral bestemd voor de richtingen met een uitgesproken component weten schappen is het signaal ook op macro niveau duidelijk. KOGEKA wil zoveel mogelijk scholen motiveren om GIS te integreren in hun jaarplannen en er een essentieel lesonderdeel van te maken.

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Sint-Dimpnacollege, KOGEKA: an obvious GISAS partner

KOGEKA is a private, catholic subsidized school community of eight secondary schools in Geel and Kasterlee (Flanders), offering comprehensive, technical and vocational education. The Sint-Dimpnacollege is the partner school presenting general education for pupils from 14 to 18 years old, preparing them for university studies.

For years already the Sint-Dimpnacollege has two trump cards that makes it trendsetter in European water projects. First of all, the school has been practising water assessment for almost 20 years. Their former teacher of biology, Mr Danny Van der Veken is an active member of the international BISEL team who adapted the BISEL method for secondary schools. The know-how and enthusiasm of the teacher encouraged both colleagues and pupils to work on water assessment and to link it with ecological problems.

In addition, the school organised its first European Week in 1992. This international event, with a delegation of each member of the EU, was the start of an international activity program that focuses on all the teachers and pupils willing and wanting to discover Europe, to invest in new educational methods, in short to become European citizens.

Every year the school coordinates several projects to create opportunities for youngsters who are eager to broaden their horizon and enhance their skills. Systematically, we organise pupils exchanges focusing on water research within subsidised projects of the European Commission. We started the first multilateral school partnership with partner schools from Porto (Portugal) and from Rethymnon (Greece). These partnerships triggered off a series of other projects: they evolved into the multinational Comenius and Lingua projects, into bilateral Euro'classes' projects and on top of that into membership of a network program (CFN). We have contacts in all the outskirts of Europe, from Crete to Norway, from Portugal to Latvia.

That is why it was but a logical step to become partner in the GISAS project. We have the expertise of the BISEL method put into practice by students; we have a database of the results and we have international partners working on the same topics. Joining a new project with the partners, introducing these data in a web atlas was the next challenge of our school.

GIS was a brand new field of investigation for us, unknown in our school as in the majority of the Flemish schools. Convinced of the importance and the interesting subject matter of the project, the school governors and the European cell decided to invest in the project, and pave the way for geography and science teachers in offering new educational and pedagogical opportunities for the pupils.

Environmental education is one of the keystones of how we see our project. All the pupils of the 4th year (between 160 and 210 yearly) experience an ecological day where they analyse the water of a local river, get acquainted with ecological concepts; and come to a clear understanding of their own impact on nature. The pupils learn how to preserve nature and become aware of the importance of a long-lasting way of living.

Though GIS was almost unknown in secondary schools in the preparatory phase of the project, my school board and I recognized its pedagogical asset for pupils and teachers alike. This project gave us the privilege to be pioneers in introducing GIS into the school curriculum.

In fact, at the start of the project, there was only a basic GIS education being developed by the geography teachers in Flanders and the educational authorities worked on the implementation of GIS in the next geography school curriculum, which became a fact in September 2006.

Launching the project at school

From the very first start of our GISAS project, we have worked on two levels: a teachers group and a students group. We also started up a geo-group and a bio-group with teachers of KOGEKA. (geography teachers and biology teachers). Regularly, we had, and still have, project meetings where we discuss the project topics, note down our findings, divide the tasks etc.

Besides the teacher level, we also work actively with pupils. Thanks to the eLearning tasks, pupils search their way in the new software, become familiar with the use of GPS, layers, dots, lines and polygons and find connections between pollution sites in the river and the surrounding land use, the residential areas, etc.

Our GISAS project activities

The project activities cover several actions spread over three years and done by a lot of actors. Here comes a survey:
As mentioned above, we have an ecological day each year for the 4th form pupils where they monitor two local rivers and assess the water quality. From 2005 onwards, only the pupils following a scientific direction have half a day of project activities regarding water quality.

The bio-group of teachers divides the sites and the sampling moments of the year among the different schools and pupils to ensure a continuation of the assessment of five spots on the river *Larumse Loop* and two spots of de *Zeggeloop* and they do so twice a year. Each period, approximatively 150 pupils are involved in the BISEL and chemical water activity. During our yearly European week, we have about 80 participants from the Sint-Dimpnacollege and their international hosts who participate, see figure 1. For the other sampling moment, more than 100 pupils, divided over the schools of KOGEKA, work on the water assessment.

Figure 1. Assessing the water quality of the Larumse Loop, October 2005, sampling point 5. Pupils from Sint-Dimpnacollege (Belgium) and ISIS Malignani (Italy) use BISEL and a chemical method to assess the water quality as part of the GISAS and the Garden of Eden project.
Figuur 1. Bepalen van de waterkwaliteit van de Larumse Loop, oktober 2005, staalnamepunt 5. Leerlingen van het Sint-Dimpnacollege (België) en ISIS Malignani (Italië) bepalen de waterkwaliteit met de BISEL methode en een chemische analyse in het kader van de projecten GISAS en Garden of Eden.

In order to locate the exact sampling points, we use the GPS to define the correct coordinates.

The GPS receiver comes in very handy to have the correct coordinates in determining the exact location and dimensions of the fields, surroundings, the nature reserves, the habitats, the residential areas and the pollution areas.

The ability of using GPS is, since the start of the GISAS project, yearly trained during our European week. One of the project activities for the international groups is to find a treasure, hidden somewhere in the city center of Geel. Thanks to the indications, discovered by interpreting codes and coordinates, the groups of youngsters follow a treasure hunt that leads towards the cache. Via a game, the pupils learn to use the GPS receiver and get aware of the locations and the geographical reality as indicator. The geocaching exercise is always conceived by the pupils themselves, the purpose of which is three-fold: not only do they learn to use the instrument in a responsible way, they also have to foresee the reactions and obstacles of the groups carrying out the task. And last but not least, they learn to imagine themselves in a certain situation. This requires some empathy which- if really they want to succeed - is especially necessary in an international team.

The GIS tasks are the biggest challenge of the project. First of all we bought the software and installed it in a computer room with 24 computers. ESRI Belgium sent a specialist to give an introductory course for our geography teachers.

Thanks to the eLearning tasks, we learned to use the program step by step. At a regular basis, I gathered with pupils to work on the project tasks and to discover the possibilities of ArcView 8.3. It was an extra challenge for the pupils because they had to carry out the tasks after the lessons. Fortunately, there were enough volunteers to work during weekends and in the evenings to carry out their homework, see figure 2.

Every year, we have new pupils, working on the European projects and learning to use ArcView. The first group, consisting of 3 pupils, made their own exercise in order for the new ones to get familiar with the software in a pleasant, realistic way. They created an exercise based on our local city to teach the newcomers how to draw a dot, a line and a polygon. This 'Homer Simpson exercise' is conceived to be made within one lesson of 50' and is an initiation into the program, made for ArcView analphabetics. The second project year, a group of 12 pupils from our school and three from another KOGEKA school continued the tasks. They were initially helped by the experts of the first hour who were there to coach them. After a while, the second group was able to work independently on the new tasks sent by the Finnish coordinator, see figure 3. For the final event, again 12 new pupils will execute the GIS work.

Since the water assessment is done by more schools of KOGEKA, also the digitalization of data on digital maps is done by more schools of our community. As we study the data of two local rivers, also for the second river, de *Zeggeloop*, four pupils made a layer to visualize the river on the digital map.

Extra muros contacts : GISAS breaking up fresh ground

As coordinator of the secondary schools of the GISAS group, we have had international teachers and pupils exchanges with our other partner schools and each time we discussed and compared the results of our findings.

Not only with the other partners did we compare our results, one of our major intentions was to compare our findings with the official results of the Flemish community (VMM) and of the city of Geel. It is satisfactory to see that the results are similar.

We are glad to say that we have had good contacts and transfer of data between the municipality and our school. Pupils went to the city authorities for information and turned it into a power point presentation. That way we got a better insight into the two rivers we follow and the restoration works the municipality is carrying out to improve the water quality of these two rivers. Moreover, all this material could work as a stimulation for the surrounding residential areas to live in a more sustainable way.

Figure 2. Lars Ghys, Dieter De Moitié and Joris Nijs, pupils of the Sint-Dimpnacollege, carry out the first GISAS learning task sent by the coordinator Mr Tino Johansson.
Figuur 2. Lars Ghys, Dieter De Moitié en Joris Nijs, leerlingen van het Sint-Dimpnacollege, voeren de eerste eLearning taak uit, verzonden door de coordinator Mr Tino Johansson.

GISAS: a learning path for pupils

In general, I can state that our pupils learned a lot during the project. I have to add that we only work with motivated pupils, willing to invest (and 40 to 50 % of the school population is in this case) enough of their free time. The pupils participate only because they are eager to learn things. They realise that in order to improve their knowledge they have to put what they acquired in theory into practice. In doing so they understand that they need to follow learning paths which are often different from what they are familiar with. They should be open to new ideas, new cultures, as they constantly meet other nationalities. This essential interest and the motivation to learn are the ideal start to carry out the project activities.

When I focus on the ArcView part of the project,

Figure 3. The second group of pupils from the Sint-Dimpncaollege is drawing the sewage system of the Larumse Loop and the layers of the land use.
Figuur 3. De tweede groep leerlingen van het Sint-Dimpnacollege tekent het rioleringssysteem rond de Larumse Loop en de lagen voor het landgebruik.

I can record that the eLearning tasks were very well explained and easy to follow for all the pupils. It gave really satisfaction when the tasks required were visualized in layers in the ArcView program and when we could put our homework on the BSCW groupware. The participating pupils gained self-confidence in carrying out the tasks, in understanding English. They learned to work in a team and to accept the strong and weak points of each participant. They developed several competences such as self-discovering learning, learning and discovering on demand, distance learning.

Especially the ArcView groups had the occasion to present their work for all types of audiences :

1) geography teachers from Flanders and Wallonia,
2) the school board of the European school,
3) a group of Hungarian scientists during a training course,
4) an audience of specialists during an eLearning conference
5) a larger number of people during the GIS-o-polis fair in Gent.

They learned to summarize their work and to present it in a structural way. Besides, they learned to practice other languages fluently and were able to help and explain the program. Surprisingly fast, they grew towards such a productive cognitive level that they found themselves able to make their own exercise, as well as to help the second group of pupils and teachers to use the ArcView software.

They have been interviewed by reporters and have seen articles published in the local newspapers and in specialized magazines.

In the periphery of the computer tasks I have also found pupils willing to visualize our activities in another creative way. They went on the field to take pictures, others filmed the activities and a third group made a movie of our project activities. The 4' film gives a good impression of the GISAS activities and can be understood by everybody.

And last but not least, during one of our European Weeks we established contact with our Finnish coordinator and we organized a videoconference with a Finnish group on one end of the line and a delegation of Belgians, Hungarians, French and Latvian pupils and teachers on the other end (in our auditorium in Geel). This videoconference was prepared, presented, technically supported and filmed by pupils. This proves that the project not only appeals to the intellectual capacities of pupils but also develops creative and innovative aspects or gives pupils all the chances to find their own way of learning, of growing and developing skills; of evolving into young, critical, independent and creative European citizens.

Starting from an environmental topic, our pupils become aware of the importance of nature and how to preserve it and they can study the subject starting from their own approach.

From active awareness to active citizenship is a small step. Six of our pupils participated at the first Youth Congress on Water Carriers in Morocco from 17 to 24 September 2005, organized by GREEN Belgium. Stimulated by the knowledge they gained with the GISAS project, they felt the necessity to share this and to go to Morocco to compare the lifestyle of the youngsters there, to experience how it feels to have lack of water. They developed an action plan to help. Their concert from October 2006 will be the start of a real helping program to ensure access to water in a small part of Morocco.

Not only the pupils but also the participating teachers enriched their knowledge, their ICT competence, their language skills and widened their horizon, which reflects in their daily job.

GISAS: a personal enrichment

As European coordinator and teacher, the project allowed me to learn and enrich also my own knowledge. I have been working with BISEL for several years already, but it was the first time I used digital maps in this way. It was a great experience to create layers and to discover in this way several aspects of one site. As teacher of languages and didactics, I am tempted to search for applications in other domains. I am convinced that this is not only useful for geography and science teachers. Other disciplines can certainly take advantage of the software.

The trainings at the beginning of the project were essential to be able to promote the project for the pupils and to start with the activities in my own school. What was even more enriching was to learn how geographers see the world, how they search for connections and explanations. As linguist you enter the world through human communication but evidently also nature, surroundings and landscapes give a lot of information and can explain specific things.

After the trainings I was able to start the project in our school and to promote it as an innovative, necessary subject for our school community. It allowed us to widen our horizon and to be active both on a European scale and on a more scientific level.

Supported by my headmaster, we started a permanent international workgroup within our school community and since this project, KOGEKA attaches real importance to international innovative educational projects.

Impact of GISAS and GIS implementation in school life

With the GISAS project coming to its end, I may say that GIS based education in our school and in KOGEKA has completely changed. Three years ago, I often had to explain the term GIS to colleagues and pupils. Right now everybody immediately links it to the project and has discovered the need to know GIS for private companies, for certain services of the municipality, for the use in the car or just for fun when somebody wants to do a geocach.

At the start, it was hard work to find the necessary, good equipment and to convince the ICT coordinator in school of the importance of installing it. At present, we have had it installed in five schools of our community and both ICT responsibles and headmasters are convinced of the surplus value of GIS education in our secondary schools. The geography teachers of the third degree (16 to 18-year-olds) use it in their lessons as part of the curriculum. Also our school for younger children has installed the software and uses it for a project with a group of 15 younger pupils (from 12 to 14-year-old). What I would like to achieve is that not only geographers but also other teachers use it in their lessons as a surplus value.

Even if we exploit only 10% of the possibilities of the ArcView software, installing it and familiarizing the pupils with this way of searching, thinking and investigating has enormous advantages. From 2006 onwards, GIS is compulsory in the third degree of secondary schools in Flanders. That is why we link our final GISAS meeting in September in Geel with an in service teacher training for all the geography teachers of Flanders and the teacher training schools. The applications in secondary schools curricula are multiple and the effort for teachers to learn to use it is basic. I can only encourage schools to start the GIS education in their schools since it teaches pupils to connect data, to think otherwise and it stimulates them to optimize their scientific, ICT and language competences.

The major practical problem for schools is the price of the software. Different teachers and employees of municipalities visited our stand at GIS-o-polis, the GIS expo of Flanders in February 2006. They envy us for the possibilities we offer our students and the scientific level of our work. Their major frustration is to convince the principal or local responsible that the investment of buying the software is efficient and worthwhile.

I met software providers who deliver free software for schools and this offers possibilities. Free software will convince schools to start GIS education and integrate it in their program.

For KOGEKA this problem hopefully will not occur in the future. We are planning to work out a follow up Minerva project. GISAS is a marvelous start: with so many adaptations and so much deepening it is possible to adapt it for more educational use and more innovative work.

We have learned a lot with this pilot project and are determined to continue; conceiving a new project sticking to the good points of GISAS and trying to avoid the shortages we experienced during this one.

Reflections on the GISAS project

Let us analyze in short the pros and cons of our project. In fact it is a success story for our school. Thanks to the Minerva project, subsidized by the European Commission, we had the possibility to buy the necessary equipment for the project and to do the required European transport costs for a good functioning partnership.

Enthusiastic teachers and pupils seized the occasion to learn more, to become aware of our own living conditions and those of our partners and to live in a more sustainable way. First there are the project activities: assessing water quality with BISEL and a chemical kit, using the GPS receiver to indicate exact locations, working with digital maps, with new software to digitalize data, making presentations, writing articles, making reports, pictures, films, preparing international workshops, guidance, working on the videoconference, making a radio program, giving interviews. Apart from project activities, the participants noted cultural, economical, social, educational differences of the other partners, which made them more critical towards their own convictions and automatisms. Not only this personal enrichment for all the participants is a fact but also the new friendships that are created makes the project a once in a lifetime experience.

But, nothing is perfect and the project also had its problems. For our school, the big problem has been and still is: the time investment of the teachers. We have a good working Europe-group with 15 to 20 teachers investing voluntarily in accompanying pupils, working out project activities. They all believe in the surplus educational value of international projects in general and environmental awareness in particular.

As European coordinator I am discharged for a part of my teaching job to coordinate and work out projects. But the staff costs foreseen in the program are highly insufficient to achieve our goals in a normal way. The work load is too high to continue these projects in the way we are facing them now.

Also a strong and complementary partnership as such is very important. The program unfortunately does not foresee measures for bad partners. If partners do not stick to the program, it may endanger the outcome of the project and the partners do not have the possibility to penalize them or to replace them by new partners easily. In this way, the success of the partnership depends on a good synergetic cooperation which cannot always be guaranteed at the start of a project. Personal situations and institutional changes can influence a partnership and the final products. Even though we have a pilot project, it is always rewarding to come to a nice end product that summarizes the efforts of the partners. If this is endangered it might leave a bitter taste.

The diversity of the partnership introduces the partners in other working worlds. Universities, private companies, secondary schools have other plannings and other priorities, depending on the country. They have other curricula, other time tables, other holidays, other exam systems etc. A good cooperation and correct agreements are really necessary to continue and search for common moments.

Dissemination and networking in the GISAS project

The GISAS project has become a concept in our school and a top-of-the-bill practice example of innovative, creative, scientific, communicative learning activities.

Within the three years of the project, our pupils have done so much presentations and workshops that our school community, our city, our National Agency, our province and also the president of the Flemish Geography teachers society know we are pioneers and invest in a good- functioning pilot project.

As I already mentioned, the project started in one school, the Sint-Dimpnacollege. After two years, two other schools of KOGEKA decided to participate and now the software is operational in 4 schools of our school community. This means we use the program for pupils between 12 and 18 years old, following general, technical and vocational education. To achieve this, a core group of my students made an exercise to familiarize teachers with the software. They gave a training session to geography teachers and interested pupils, see figure 4.

The European School of Mol, situated in our neighbourhood, is interested in following our example. Their headmaster and a team of science teachers came to our school for an introductory session.

Figure 4. Lars Ghys is coaching the geography teachers of KOGEKA. They have an ArcView initiation via the 'Homer Simpson' exercise made by the pupils.

Figuur 4. Lars Ghys begeleidt de aardrijkskunde leerkrachten van KOGEKA. Ze krijgen een Arcview initiatie aan de hand van de 'Homer Simpson' oefeningen, gemaakt door de leerlingen.

ESRI, our software provider, invited us twice to give a presentation during their yearly organized “user days for schools”. Two times, I went with pupils to Wemmel (Brussels) to demonstrate the geography teachers of Flanders and of Wallonia what we do within the project. Later contacts with teachers confirm the impact of our students’ explanations. It all seems really difficult at first sight but our pupils explain in simple terms the immediate impact of the use of our scientific activities and the increasing awareness of the participating youngsters.

Two really challenging dissemination activities were the eLearning conference in Brussels (19-20 May 2005) where the pupils could share the stand of our coordinator Mr. Tino Johansson and the fair GIS-o-polis (22 February 2006) where our pupils had a stand and gave a presentation, see figure 5.

Figure 5. Pieter Robert and Pieter Maes, pupils of the Sint-Dimpnacollege explain the GISAS project activities in the GIS-o-polis fair in Ghent.
Figuur 5. Pieter Robert en Pieter Maes, leerlingen van het Sint-Dimpnacollege leggen onze GISAS project activiteiten uit tijdens de GIS-o-polis beurs in Gent.

Our city of Geel uses ArcView for environmental planning. Through our cooperation we exchange a great number of data and maintain mutual contacts. For the final SM@K event in Geel, the city is responsible for a workshop with pupils to illustrate GIS in practice.

As European coordinator of the Sint-Dimpnacollege I try to integrate our project activities in the other *Comenius* projects that we coordinate. Parts of it are implemented in the *Garden of Eden* project and the *Home GREEN Home* project. Together with secondary schools from Czech Republic, Poland, France, Norway, Portugal, Slovenia, Rumania, we assess the water quality of a local river with BISEL and the same chemical parameters as the GISAS project. We link the water quality to plant indicators or to sewage systems but we do not digitalize the results since the budget of *Comenius* is insufficient to buy ArcView software.

In the *Free Your River* project, another Minerva project coordinated by WWF Austria, in which we are partner, we have established links with GISAS such as working with digital maps to locate the river, adding coordinates to the sampling points, assessing water quality with BISEL etc.

Our national agency asked me to have an exhibition corner for one of the information moments they organized for higher education schools and teacher training schools.

Two pupils gave an ArcView training session to a group of Hungarian scientists and teachers.

These disseminations are also reported in several articles. Each trimester, our school publishes a magazine for the parents, where I describe the recent developments of the projects. Also in the yearly magazine for alumni, the project descriptions are an established part. Our presentations in Brussels got the attention of a journalist working for a specialized geography magazine. And of course for each important presentation of our pupils, the journalists of the local newspaper ‘ Nieuwsblad van Geel’, and those of two major national newspapers ‘Laatste Nieuws’ and ‘Gazet Van Antwerpen’ write an article and publish it to inform the population. Also for each international week we organize project activities and one of these activities is biking to the Larumse Loop or the Zeggeloop, the two local rivers we monitor. We assess the water quality and when one of the schools is also a GISAS partner, we introduce an ArcView workshop. Our GISAS activities can be followed on the school’s website and for the final event, students are creating a SM@K website.

For the final meeting of GISAS in Geel from 17 to 23 September 2006, we organize workshops with GIS applications, with GPS exercises, with water assessment, etc. We foresee an in-service teacher training for teachers of geography and sciences of Flanders.

This mega GIS event is organized in combination with other Socrates subsidized projects. It is named SM@K (Socrates Meeting @ KOGEKA) and more than 400 European youngsters and 60 European teachers will participate in workshops; they will discover our culture, our history. Can one think of any better educational road for youngsters to follow in order to create a united Europe than the one I have tried to explain?

Acknowledgements

GISAS and the linked activities and projects have opened up new horizons. Thanks to the Socrates program of the EU and the help of the national agencies, this project has been approved and subsidized.

Such results are only possible with the support of many persons. First of all, I want to thank all the GISAS members for their sharing of knowledge, enthusiasm, help and friendship. At school, I can always count on my headmaster, Mr Luc Briers, whose trust and faith gave me the support and independence needed to achieve this project. Also the school board of our school community has chosen for European projects as an essential part in the education of youngsters. The European team of KOGEKA, presided by Mr Danny Van der Veken and represented by Mrs Ann Van den Meutter, and the international workgroup of our school, Eurodimpna, presided by my colleague Mrs Tina Bens and myself, were always available. We had often meetings for the teachers who had to prepare tasks to be executed and to coach the pupils where necessary.

Our pioneer pupils who were active from the start also deserve a special mention: Lars Ghys, Dieter de Moitié, Joris Nijs and later on Pieter Robert.

And last but not least there is my family who allowed me to work on this project as I felt necessary. Without their patience and understanding I never would have realised all this.

KOGEKA & GISAS: a SM@K experience!

Sense the SM@K side of life

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GISAS: A European and International Challenge in Education, Training and Research

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In France, GIS is not often used by teachers and trainers. But the national curriculum for geography encourages teachers to use GIS, new pedagogical supports and innovative strategies. At the same time, the Ministry of Education in Paris collects information about GIS resources, tools and models in Europe and in the world in order to develop it in the schools. There are two main reasons for this: young people like new technologies and the internet offers students and future citizens digital information and materials which are easily available thanks to globalization.
In our GISAS project, teachers in different subjects piloted by the Department of Geography University of Helsinki, have discovered, taught and disseminated GIS. In the process, a new form of cooperation emerged in education, research and training, with new friendships, new networks and perhaps an Econtentplus project for the future, EuroGENiE (European Geospatial Enterprise Network in Education).

En France, les SIG ne sont pas souvent utilisés par les professeurs et les formateurs. Mais, le curriculum encourage les professeurs de géographie à utiliser les SIG, de nouveaux supports pédagogiques et des stratégies innovantes. Au même moment, le Ministère de l'Education à Paris collecte des informations sur les ressources, outils et modèles en Europe et dans le monde pour les développer à l'école. Deux arguments principaux : Les jeunes aiment les nouvelles technologies et Internet offre aux étudiants et futurs citoyens des informations et des supports numériques faciles d'accès à cause de la globalisation.
Dans notre projet GISAS, professeurs de différentes matières, pilotés par le Département de géographie de l'université d'Helsinki, nous avons essayé de découvrir, d'apprendre et de disséminer les SIG. En chemin : une nouvelle coopération en éducation, recherche et formation, de nouvelles amitiés, de nouveaux réseaux, avec, peut- être, un projet Econtent plus pour le futur, EuroGENiE.

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Situation of GIS in France

GIS is not well known in our educational system. Few teachers seek to innovate and to work with new media or the Internet in their courses. I know that GIS is more developed in other European countries, such as in Finland, England and Denmark and that more teachers are trained in Germany.

Our French Ministry of Education in Paris started a two-month mission in July 2006 to learn more about GIS resources, tools, models and costs, on the European and international level in order to develop their use in secondary schools. There are two main reasons for this: young people like to work with new technologies and software, which they master very quickly. Internet offers students and future citizens - but also teachers - digital materials which are easily available thanks to globalisation. The information can be shared in real time around the world.

So changes are planned in education; new materials and methodologies are encouraged.[1]

My experience with GIS enables me to imagine another role for it: because of internationalisation and the more frequent, short-term mobilities of citizens, it has become very important to have our own representation of this evolving space, to be able to measure the distances between the towns we visit, to use GPS and GIS. It helps to have a real vision of a complex world.

In our school, the curriculum introducing GIS on

[1] A new guidebook for geography teachers: Clés pour l'enseignement de la géographie, Lycée, Collection: "Démarches pédagogiques", Scérén, 2006.

a voluntary basis has not really affected the geography teachers. We do not see them often in the computer rooms. I think it is the same situation all over France, with the exception of very innovative teachers fond of computer technology and GIS.

As a researcher giving presentation on GISAS, I have come across some very interesting projects from French teachers. One teacher walking in the school with his students, notice the amount of rubbish on the grounds. They suggested that the garbage bins were probably not well-situated. So they conducted a survey to follow the students' paths and discovered with a GIS software a new functional location for the garbage. It was good for the environmental issue in the school.

It will take time to change attitudes, but it is important that innovations enter the classrooms and GISAS has this function. For three years now, my physics colleague, Mrs Blandine Faucher and myself, a German teacher and teacher trainer, have become really involved in GIS.

Discovering GIS In Romania in 2000

I had the chance to discover what students can do with GIS in 2000 in Romania during a European project meeting. At that time the GIS software was used in a cultural project to make a virtual visit of museums in the town of Iashi. I was very impressed by the skill with which the students manipulated the software and impressed that despite the economical difficulties it was possible to implement very new software that I had never seen in France in Romanian education. I remember that "Telerom", the national phone company, equipped the school because one student's father- and the student herself- were very fond of GIS.

Working in the GISAS project

This experience incited me to join the GISAS project. Since the beginning, I am convinced that GIS will be implemented in school education, but we have to be able to find new applications in other subjects. Our manager and coordinator, Petri Pellikka and Tino Johansson, have stated, " (…) GIS is much more than a computer-based mapping tool. GIS is a system for managing, storing, analysing, modelling and visualising spatial information."[2]

One of my roles is to find new ways to use GIS at school. However, it takes time to learn to use the software and then to transfer these skills. Personally, I teach in two schools, coordinate other projects in several languages and work on GISAS- like many teachers- on a voluntary basis.

GISAS project activities in our school

Figure 1. Our school, the Holy Heart Institute in La Ville du Bois – Notre école, l'Institution du Sacré-Coeur à La Ville du Bois.

Our school is located 25 km south of Paris in a little village and in a beautiful park. It has 1200 students between ages 12 and 18 as well as 90 teachers. We introduced the GISAS project in a class with students at the ages of 16. We had one hour each week with them. The problem is we have new students each year learning GIS and the other teachers don't follow our work. But around 80 students had an introduction to GIS between 2003 and 2006.

[2] Johansson Tino and Pellikka Petri. Interactive Geographical Information Systems (GIS) Applications for European Upper Secondary Schools. In Recent Research Developments in Learning Technologies (2005).

Fieldwork for collecting the water quality samples with BISEL

During the last three years we have carried out five water analyses with the project class. It was a multidisciplinary experience with the physic teacher, Mrs Faucher, the biology teacher, Mrs Rakotomanga, and I, German teacher and French coordinator.

The students like to go in the field and to measure the quality of the water of their local river. They prefer to be in nature with their friends rather than to sit in a classroom working with teachers.

Figure 2. The students using the GPS to localize our river Rouillon- Les élèves utilisant le GPS pour localiser la rivière Rouillon.

The *Rouillon*, our small local river of 8 km, flows through a rural area and several different municipalities. It lies in the Ile de France region. We have two main sources of pollution:

Agricultural pollution: the major part of the *Rouillon* course crosses fields, which explains the high level of nitrates and the bad quality of the water at our three sampling points. Fertilizers used by local farmers probably have an impact on the quality. We know that the results in spring are the worst of the year and that this period corresponds to the treatment period for the fields.

Problems with sewage system: wastewater is completely channelled and follows the *Rouillon*. Wastewater is finally diverted towards a larger river slightly before the end of the river. During plentiful rains, there can be accidental discharges of the sewage system into the river. Pluvial waters pour directly into the *Rouillon*.

Local politics: It seems that the municipalities want to protect the environment. To prevent the two kinds of pollution, they have built new settling tanks and repaired the sewage system along the Rouillon and must do the same for another little river, the *Ruisseau Blanc*. As the river sometimes overflows, the municipalities have to prevent that with an artificial basin under construction upstream and must maintain the riverbanks in good condition.

Use of GIS: it helps us to know all the environmental details around our three waypoints. We can select only the layers that we need in order to visualize the problems in water quality.

Figure 3. Students doing the GIS exercises with the manual – Les élèves faisant les exercices SIG avec le manuel.

Figure 4. Students learning to work with Arcview 8.3 and their teacher Mrs Faucher – Les élèves apprenant à travailler avec Arview 8.3 et leur professeur Mme Faucher.

Using ArcView in our school

Twenty to twenty-five students work on projects during the class hour but the group is too large. Mrs Faucher is more competent in computer technology and scientific subjects and she teaches the students most of the time and guides them how to use GIS in the classroom. They use GPS in the field during the water analysis. It often happens that a student using the new GPS says to me: "How easy it is! It is only a little computer!"

Mrs Faucher describes this experience in the following words:

"During this third year of GISAS (2005-2006), I have taught GIS in two different situations.

The class was divided 2 hours each week according to their chosen option.

-The first group, with students who did MPI (computer - assisted physical measurements) with me, had the possibility to learn the use of ArcView during 6-7 lessons spread over two periods. These students were mixed with five others students from other classes, which were not from the GISAS project. This added some difficulty, as they required more explanations.

The first lessons were well assimilated: the river polyline and BISEL events. The pupils tended to follow the figures however and not to read the text. That's why, sometimes, they had to do their task again. The lessons were taught in French because it's still too difficult to manage both the English language and the use of ArcView at the same time (we have a French version of ArcView).

Students have difficulties following the instructions accurately, but this is not specific to this subject.

Furthermore we provide courses about recreational areas, pollution and animal habitats, but the students don't know enough about the river and its environment. I help them because I have lived near the Rouillon for several years. They also use the raster map, which gives them information.

For the pollution shape file, we had no precise pollution point and we had to discuss the river location. We have searched together the different pollution issues, their possible reasons and locations. The SIAVHY (water syndicate of the Yvette valley where the Rouillon flows) has helped us: they gave us documents, data and an expert came to discuss with us and answer our questions.

***For the animal habitat shape file**, we had no data and we still have none.*

***For the land use types**, the raster map was very useful. During the lesson they drew only some examples of land use. As it's a long process, if we want a good layer, we need to spend more time to go and visit the actual site. However, we are short of time, and the main objective was to learn how to do it. The division in five groups was possible of course, but this still required too much time. For the next lesson, I had completed the layer myself and we took a long moment to ask about the different land uses in order to have a good knowledge of the layer.*

***For the soil type,** we had only one geological map. It's difficult to manage the drawing of the layer with only one map. We discussed the map. We defined the different soil types and their characteristics, but only one group drew the layer.*

***For the sewer systems**, the SIAVHY provided us with some general data. Normally we need the agreement of each town along the Rouillon in order to have a precise map of the sewer systems. But we had no time left to do that: the lessons had ended with the pupils; therefore I drew the soil type use layer myself with the SIAVHY explanations.*

On the other hand, the students had learned the buffer tool and how to make inquiries with ArcView. I think that this part would be more interesting if we were using the data from the other European schools, because the pupils would ask each other more questions.

- The second group with students who don't take part at the MPI course have learned the use of GIS, but too quickly, and not in ideal conditions.

We had only 45 min and sometimes less, during the project European lesson".

Teachers' and students' training with a German assistant professor at school

Last year I invited a GIS expert, Mr. Schaefer (an assistant professor of German at the University of Mainz) to train us: one day for teachers, the next for students. It was a very successful experience. Eight teachers from different subject areas - one in geography - took part in the training despite language difficulties: in the beginning I translated and after half a day each teacher was managing alone in German, English or French. Even if it was not perfect, they were able to communicate together.

The students were very proud to show him their new PowerPoint presentation about their GIS work in three languages and also made presentations about their day with “Dr. Schaefer”.

GISAS teachers’ opinions about the project

My colleague Mrs Faucher and I, the French coordinator, faced many obstacles but managed to overcome them. We both agree that there are two main obstacles: first, we need the help of the Geography teachers. There are around eight of them at the school and they teach geography, history and civic science three hours a week. It would also be nice to work with other teachers but they all say “no time”. Second, the time is very short and the group is large, with an hour where sometimes we have many things to do. Third, although our director is open to European projects, I have coordinated since 1997 but wonder if the school community has really measured the challenges we had to surmount every day as well as the many obstacles; do they realize the potential of such a pilot project for the whole school? Idem for the School Board: the Academy of Versailles is one of the biggest Academies in France but has only one Minerva project, GISAS.

Are we successful? Our team is very small; we teach different subjects but are very complementary. We both like the GISAS project for different reasons and try to be as efficient as we can even if we have a lot of work. We were successful in the translation of the GISAS manual: 150 pages to translate into English so that the French version can perhaps be edited, without being specialists and without the help of English teachers. But we enjoyed this new work: Blandine specialised in the screen shots and I in the translation.

We are also happy to see that many students like to be involved in the project, come very regularly and learn a lot: to be self-confident, to work alone, in a team or in a workshop, to develop their skills in computer technology and become innovative.

It is very important that they explore new pedagogical software, which can open their minds and give them new skills. They now know a lot about their region, because I have also invited an expert on the environment and another on water.

The students liked the form of the exercises that our Finnish coordinator, Tino Johansson provided. We noticed that they first looked at the screen shots, reading the text only when they were not sure to have understood the screen shot.

The students and we would like to share our GISAS experience with our new European friends, communicating via webcam or our collaborative workspace, Bessie. This is surely the next step. I hope we will begin this year, perhaps with another project.

The challenge of a student: working 200 hours for GISAS (2004-2006)

After hearing from a professor, it is important to hear the voice of the students. I have chosen Alexander’s voice to explain how grateful he is to have worked on the GISAS project.

Alexander is 13, not in the project class and came voluntarily. He was a very reserved student but has now carried out 2 GIS presentations for experts at the ESRI SIG conferences with his “new GIS friend”, Pauline. In the beginning, I noticed that he was talented in GIS and liked to train, to develop new skills and also to explain them to other people. So Alexander became self confident and also surmounted many obstacles: to be with older students, to have English tasks sometimes, to take time. At the end of this year I invited him to count the hours he had worked with us or alone in the computer room: in all he carried out 200 hours, every Wednesday afternoon, in just two years! I helped him to write his diary and we stayed at school two weeks after the other teachers at the end of the year , but his diary was ready, in English with screen shots and satellite images he chose to accompany his text.

Alexander’s opinion about the project

Alexander explains his experienses on ArcView, Arc catalog, and his new capacities, in his answer to a questionnaire from a University of Helsinki researcher, Mrs Ilta-Kanerva Kankaanrinta.

“ArcView: Three functions are essential for me: Information, Buffer and Zoom. They are also easy for me. I have presented these tools at the ESRI conference SIG 2005. The function “ Zoom back constant” is for me the most irrelevant. I find the task “Drawing the river” very easy, because I have used it very often. The task with the attribute table is the most difficult for me.

ArcMap: I find it interesting to make the local map with our river Le Rouillon, 8km long near our school.

It was not possible for me to go into the field because I am in another class, but I used the data that the older students collected and put them in the attribute table.

ArcCatalog: We use it to create files (Shapefile, attribute tables) which will be used to create layers on the map.

Use of ArcCatalog: For me the task "Making the different layers" is the most interesting. because I learned more about my region.

For me the task "Adding the BISEL data" is complicated.

My new capacities thanks to GISAS: I can make powerful and interesting PowerPoint presentations; I know how to use the software Arc-view 8.3, a GPS and I improved my English.

My biggest strengths: I learn and can work very quickly with the software.

Work with GIS and effects on learning about water quality and environmental issues: I could notice the pollution of the river which passes close to my home and become aware of it and even of the pollution of my planet!!! Now I know more about my region, and for that I thank Mrs Lavollée.

Work with the GISAS manual: The GISAS manual is very useful, because I can read the screen shots very easily and interpret them. When I read "Click on the file", I see the file on my screen and I click.

Work with GIS is a challenge.

For me these challenges have taken a lot of my time, but it was for a good cause and that is why I accepted to work hard. But if I couldn't succeed at something I went on to another thing.

My new role and my new relationships: My relations with Mrs. Lavollée and Mrs. Faucher have changed. They have more confidence in me and this has allowed me to know them better and now I work with older students in the class of Seconde.

Between the professors and me there is a relationship of confidence because they lend things to me and I help them. For example Mrs Lavollée allows me to use her computer and in return I help her to carry out PowerPoint presentations.

This project enabled me to become aware of the pollution of my river and now I pay attention to the environment by small simple gestures. I have been able to work and exchange with various people such as the school headmaster, the staff at UNESCO and some teachers like Mrs Lavollée, Mrs Faucher and students of the class Seconde.

I would not have known these people and become close to them if I had not participated actively in these projects.

I was able to use new technologies like GPS, the computer, webcam or software such as ArcView, Microsoft PowerPoint and many other tools."

The last sentences in Alexander's diary:

"In conclusion, I can say that these projects were very positive!!! I thank all the people who have helped me and given me a chance to develop my skills and perhaps to find my vocation."

Some remarks of the author

About the interest of the students: The students are more interested: they are more active in the field and making their own maps on the computer than if they were to learn only in the classroom with their book.

About my own learning process: I have found the in-service teacher training very interesting. I really discovered how to use unknown software. I was curious but it was very difficult. The lack of time makes the tasks more difficult, but the variety of tasks in the project enabled me to learn a lot.

I am very happy about the conferences I had the chance to participate in because all the papers were accepted and were successful even if in the beginning I was reserved and it was not very easy as an n onspecialists to speak to experts. After my conference at the French Commission of UNESCO with Blandine and the students, the head of ESRI-France, Mr. Rony Gal, offered us both trainings for free. It was very helpful, particularly for Blandine, who underwent a whole week of training. After the last conference in San Diego at the EdUC2006 I was invited with the GISAS group to join a future *Econtentplus* project, EuroGENiE, piloted by a GIS expert in education, Mr. Karl Donert. So we can perhaps hope that the GIS adventures and European friendships will continue beyond these three years and that there will be more networking.

Dissemination and networking in the GISAS project

Disseminating a project such as a pilot Minerva project is very important so that other people may discover it and perhaps join and network.

ESRI-French Conferences SIG 2004, SIG 2005, SIG 2006 and publications of GISAS
I have disseminated our GISAS project with my colleague Mrs Faucher and four students at the French ESRI conferences in Meudon, near Paris. Two of the best students presented how they use ArcView 8.3, the other two students prepared a report with photos to present to the other students.

Figure 5. Two young students, Pauline (12) and Alexandre (13), presenting the GISAS project at the ESRI conference SIG 2005- Deux jeunes élèves, Pauline (12) et Alexandre (13), présentant le projet GISAS à la conférence ESRI SIG 2005.

Figure 6. The French Coordinator, Mrs Lavollée, disseminating the GISAS project at the International ESRI Conference EdUC 2006, in San Diego- La coordinatrice française, Madame Lavollée, disséminant le projet GISAS à la conférence Internationale EdUC 2006, à San Diego.

ESRI European conferences
With my Swedish partner, Tjorbjörn Larsson. we presented our GISAS project in Copenhagen in 2004 and I presented it in Poland in 2005.

ESRI international Conferences EdUC2005, EdUC2006 in San Diego, California
I presented the GISAS poster, made by our coordinator, Tino Johansson in San Diego in 2005 and this year had the chance to be invited by the head of ESRI-France, Mr Rony Gal, to make a presentation of our GISAS project.

Sm@k
This European week, coordinated Mrs Manuela Borgh from Belgium, will bring around 400 students and teachers together in Geel, Flandern. GIS will federate the partners of many different countries.

INRP, Cyberlangues
I also presented the project with a Romanian and a German researchers and friends at the international meeting of the Institut National de la Recherche pédagogique (INRP) in Lyon in 2005 and 2006, and at *Cyberlangues*, a meeting for language teachers in 2004 and 2005.

GIS day
With the students, my colleague and I have presented our GISAS work. The project was also presented to the whole school community during the pedagogical days in our school.

Local authorities in La Ville du Bois
With my colleague Blandine we have presented the project to the city councilors. Collaboration with the future econtentplus project, EuroGENiE. It will be great if GISAS can have new roots in an important network with national, European and international authorities in education and factories with GIS expertise.

Youth Eco-Parliament in Paris

After the GISAS project ended, we also disseminated its activites, exercises and outputs in Youth Eco-Parliament (http://www.eyep.info/) in Paris where 3600 students from 14 countries took part in. The use of GISAS materials and other outputs will continue at our school and in new project in the future.

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At the school:

To the head of our school who has given me the opportunity to carry out projects at school and the time to discuss with him and ask what he wants to decide for the school. To my colleague Blandine who has provided very friendly and very decisive help in order to surmount many obstacles. I invite all the colleagues who are interested to join our little team.

At ESRI France:

M. Rony Gal for giving me the possibility to take part in the conferences and training courses. Even if it means a lot of work, it is very interesting for me.

At the department of Helsinki:

I particularly thank Tino Johansson for the mountains of work and tasks he made for us and his comprehension if I sent my work late. He was also very helpful in the preparation of my conference in San Diego this year; it was very nice to have Petri Pellikka during all our project meetings. Ilta-Kanerva Kankaanrinta has encouraged me very often and particularly to present the project in San Diego.

All partners of the GISAS project and the experts, because it was so great to meet and to exchange our work, experiences and ideas.

The European Commission for making the project activities possible and for giving us the possibility to cooperate at different locations in Europe. I think, even if GISAS is a drop in the ocean, it has contributed to developing the "European space" in education, research and training.

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The use of GIS at school

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Computers and other modern technologies have become common educational tools at schools in the last years in Latvia and the "Computer studies" lessons are included in the school curriculum, not only in secondary school education but also in the Elementary school programmes. Different computer programmes have become the pupils' daily life both in- and outside the classroom. The importance of using modern technologies in the classrooms has generally increased during the last years and is being supported by the government. "We don't learn for school, but for life!" We, the teachers, are aware of the fact, that school should prepare students for the future lives.
GIS have not been widely used yet in elementary and secondary school geography education in Latvia. In the near future GIS likely will be included in the school geography and the other subject curriculum, therefore many teachers participate in the international projects about GIS in which they learn much about the usage of modern technologies.

Pēdējos gados datori un citas modernās tehnoloģijas ir vieni no galvenajiem izglītības līdzekļiem Latvijas skolās un ir ieviests obligāts priekšmets "Informātika" ne tikai vidusskolās, bet arī pamatskolu izglītības programmās. Dažādas datoru programmas ir kļuvušas par skolēnu ikdienas dzīvi gan stundās, gan ārpusstundu nodarbībās. Moderno tehnoloģiju izmantošanas nozīme stundās ir būtiski palielinājusies pēdējos gados, un šīs programmas atbalsta Latvijas valdība. "Mēs nemācamies skolai, bet gan nākotnei!" Mēs, skolotāji, apzināmies to, ka skolai jāsagatavo skolēni viņu nākamajai dzīvei un darbam.
ĢIS (Ģeogrāfiskās Informēšanas Sistēmas) nav plaši izmantotas ne pamatizglītībā, ne vidējā izglītībā ģeogrāfijas stundās Latvijā. Tuvākajā nākotnē ĢIS, iespējams, tiks iekļauts gan ģeogrāfijas, gan citu priekšmetu izglītības programmās, tāpēc vairāki skolotāji piedalās starptautiskos projektos par ĢIS, kuros viņi mācās un iegūst iemaņas par moderno tehnoloģiju pielietošanu skolā.

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Introdution

At the end of the 20th and beginning of the 21st century, school is changing in many ways, facing the new world, where Internet and e-mail make it easy for anyone to find any information they need and to be connected with anybody else in the world. In this new world, schools cannot be isolated. What is the impact of school education upon our young pupils in this new world? It is the fact that the importance of school is greater than earlier in order to prepare the way into the adult world.

The general aim of the GIS project is to develop a model and ways in which GIS are applied to our school education and to both pre- and in-service teacher training. The more specific objective is to develop the skills of how teachers and students can gather data, use GIS applications, create digital maps, make analyses and communicate with each other.

The introduction of new and modern technologies and new software can increase the computer comfort zone outside the classroom, that is, the pupils of our school acquire skills doing investigations, collaborating while collecting different data, making the database using of different tools analyzing the results that demands greater skills from the teachers. The teachers need more extra time and energy to work and to create different learning experiences for their pupils.

The teachers of this school try to decide how GIS can be most appropriately applied in the school educational programme about environmental problems. In the spatial context GIS becomes a general tool for teaching and learning pupils to acquire and solve problems.

In Latvia students in high schools and universities have recently started to acquire GIS in geography and environmental education, although computers are widely used both in high school and secondary school education. GIS technology is not widespread yet at schools in Latvia. The hardware, necessary for GIS work has already been bought and applied for the needs and work in environmental studies only in our school in Latvia.

Different projects function at our school concerning the environmental studies, such as: coast watchers, forest investigators. But these activities have been carried out in – out - of school activities. Some changes are being planned in future and the project work should be included in the school curriculum.

Internet access is possible for every our pupil, it enables to work with spatial data, it helps explore information and solve different problems by integrating geography with science, maths, languages, music, arts and etc.

Introdution in Latvian

20. gs. beigās un 21. gs. sākumā izglītība mainās nepārtraukti, nonākot saskarsmē ar jaunām tehnoloģijām, kurās Internets un elektroniskais pasts atvieglo katram skolēnam atrast jebkuru nepieciešamo informāciju un uzzināt par jebkuru cilvēku visā pasaulē. Šajā modernajā pasaulē skola nedrīkst būt izolēta. Kāds ir izglītības impulss mūsu skolēniem šajā modernajā pasaulē? Tas ir fakts, ka izglītības nozīme ir kļuvusi svarīgāka nekā agrāk, lai sagatavotu skolēnus pieaugušo pasaulei.

ĢIS projekts skolā balstās uz teorētiskām zināšanām par ĢIS pielietojumu, ģeogrāfijas mācīšanu, datora apmācību un jauninājumu izplatīšanu. Projekta darbības laikā iegūtie izpētes rezultāti tiek pielietoti praksē un vienlaicīgi jauni izpētes temati ir apspriesti un piedāvāti, lai, izmantojot dažādas metodes, iekļautu ĢIS izglītībā.

Jauno un moderno tehnoloģiju ieviešana un jauno tehnisko līdzekļu iegāde var palielināt šo līdzekļu izmantošanu ārpus klases telpām, tas nozīmē, ka mūsu skolas skolēni apgūst iemaņas, veicot pētījumus darbojoties grupās vācot dažādus paraugus, veidojot datubāzi, pielietojot aprīkojumu, analizējot rezultātus, un tas pieprasa plašākas zināšanas un iemaņas no skolotājiem. Skolotājiem ir nepieciešams laiks un enerģija, lai strādātu un veidotu dažādu mācību apguves pieredzi skolēniem.

Mūsu skolas skolotāji cenšas strādāt tā, lai ĢIS varētu atbilstoši iekļaut un izmantot izglītības programmās par vides problēmām. Plašākā kontekstā ĢIS kļūst par svarīgu līdzekli, mācot skolēnus tos apgūt un risināt dažādas vides problēmas.

Latvijā augstskolu un universitāšu studenti tikai nesen sākuši apgūt ĢIS ģeogrāfijas un vides izglītībā, kaut gan datori jau ir plaši izmantoti augstākajās un vidējās mācību iestādēs. ĢIS tehnoloģijas vēl nav plaši izmantotas Latvijas skolās. Aparatūra, kas ir nepieciešama ĢIS darbam ir jau iegādāta un izmantota nepieciešamajam darbam vides studijām Latvijā tikai mūsu skolā.

Dažādi projekti darbojas mūsu skolā kas attiecas uz apkārtējās vides studijām, tie ir krastu vērotāji, mežu pētnieki, u.c. Šīs aktivitātes tiek veiktas skolā un ārpus skolas nodarbībās. Dažas izmaiņas tiek plānotas nākotnē un projekta darbs tiks iekļauts skolas izglītības programmā.

Pieeja internetam ir iespējama katram mūsu skolas skolēnam, tas sekmē darbu ar datu apstrādi, tas palīdz izmantot iegūto informāciju un risināt dažādus jautājumus, integrējot ģeogrāfijas stundas ar dabaszinībām, matemātiku, valodām, mūziku, mākslu utt.

GISAS project activities

It is not a secret that the teachers have to motivate pupils in various ways, because their lack of interest in learning is clearly felt. One of the motives that may stimulate pupils in their learning is using GIS in the classroom.

Since the beginning of the Minerva project "GISAS", a lot of GIS activities have taken place in our school following the most important goals and tasks of the school programme. They are: to supply the pupils with knowledge as a base for further studies; to prepare them with different skills for the labour market; strengthen the self - respect of the young learners; make the pupils conscious and critical citizens well prepared for future life in the modern democracy.

Therefore it is very important what we teach and how we teach. The world is changing all the time and the school has to adapt its activities to the changing society. Of course pupils have to acquire knowledge of basics and their learning at school is of vital importance and learning can never be finished. Therefore new ways of teaching must be invented and applied at school work to arouse the pupils' interest. The teachers are obliged to make as much effort as they can to motivate the pupils.

As teachers we have to develop not only basic knowledge, skills, understanding and values of our pupils but also their creativity, interests, confidence, enjoyment of learning, their motivation, consciousness and responsibility for their learning.

Our school was very interested in GIS project and gave us all the necessary support. We had close contacts with our municipality.

A lot of field work of collecting the water quality samples with BISEL has been done regularly. We have chosen six different sampling places with the distance of 200-300 m from each other on the river Kresle which is approximately 19 km long and is a tributary of the river Icha. The water is rather clean and the bottom of the river is clearly seen. The pupils of our school collected the different samples of the macroinvertebrates in the river Kresle with great interest, see figure 1 and determined them and calculated the Biotex Index. The pollution of the water is very slight. The Biotic Index was 8 in 2004-2006, it means: slightly or almost unpolluted. The biological and chemical analyses were carried out repeatedly at different times in September and May. The quality of the water in all the 6 sampling points was good.

Local BISEL data collection points are located into WGS84 coordinate system with the use of GPS

Figure 1. The pupils of school collected the different samples of the macro invertebrates in the river Kresle.
Foto 1. Skolēni ievāc dažādus bezmugurkaulnieku paraugus Krēsles upē.

(Global Positioning System) receivers. These points are placed on a map with GIS software and different attribute data, such as the results of the biological and chemical water analyses, are stored and added on the attribute table's rows each representing one point object on the map. This part of the work was one of the most interesting for the pupils.

The water quality analysis was carried out with the help of different methods and activities. The basic GIS activities, especially using ArcView 8.3. programme, supported the learning and studying the water quality, such as: visualised sample point locations, marked the points of the pollution, visualised the landscape of the vicinity and the end product was making the local map. The pupils visualise the results by overlaying the water quality database with other GIS data layers on local raster map, see figure 2.

Figure 2. The pupil makes the data layers in ArcView programme.
Foto 2. Skolniece veido datu slāņus ArcView programmā.

Using the ArcView GIS database, for example with digital photos, was interesting and useful work for the pupils. It was necessary for the pupils to understand the relationship between data, maps and how map images are produced.

The pupils of the ninth form who are 15-16 year old ones did a lot of interesting and useful work at GIS lessons. They measured the distance to school, marked the location of the most important places, used GPS during the analysis of some locations outside the classroom, worked in small groups (3 pupils in one group), worked in the computer room: marked the determined spots on the map with the ArcView 8.3. programme.

Pupils learned about data layers, digital maps and how digital maps illustrated the information (after the adequate measurements with GPS, they acquired some skills with ArcView 8.3. programme). After some lessons the pupils shared their information with their schoolmates and those from the neighbouring school and with the local municipality. They also studied different technological tools, tested these tools in collaboration with the neighbouring school and with all the teachers of their school, participated in the questionnaire, reported their study results regularly, presented their end product and made a table with some drawings.

Pupils actively participate in the field work collecting water samples, determinate the water quality, measuring, making analysis and testing, making reports, collaborating in teams, communicating, expressing their views, opinions and ideas about the ArcView tasks. Some of the pupils considered them very useful and they liked to work with ArcView. ArcView tasks were well prepared and the pupils could follow them step by step. The fieldwork was useful in some ways: developed skills in communication; did the work in a team; expressed critical thinking about their work; understood the importance of practical work.

Having returned to the classroom they were better able to determine what additional work should be carried out (analysis, data mapping, testing, classifying data and making tables) while doing this work pupils felt some responsibility for it, understanding about the usefulness of their work and the acquired results. Pupils regularly attended the data collection places according to previously worked out plans for getting additional information about the water samples, water pollution.

Throughout the project the pupils monitored a number of different information, sources to capture and analyse any biological, chemical, social and physical environmental data that might be important in their problems solving.

We consider that the most important and successful project activity for environmental education at our school is: collection of water samples with BISEL method (fieldwork); work with new technologies, work in groups, testing, making analysis and reports; improving their knowledge in the subjects. The biggest obstacles during the project were shortage of time and emptiness in the curriculum. The biggest successes of the project were new knowledge about GIS and the use of modern technologies; purchase of the hardware; interest of the geography teacher.

Some suggestions teachers who will start to use GIS at school in the near future will have to: read all the possible information about GIS; participate in – service teacher training projects; do fieldwork together with pupils; include the GIS project in the school curriculum; to work out the questionnaire about GIS at school.

The teachers' learning process during the project was useful and interesting, though rather difficult and complicated. The best part according to our experiences was: work with ArcView programme, learning the information at in – service teacher training; applying GIS in environmental studies; fieldwork with pupils. The worst parts according to our experiences were: not enough reference books in the native language; not enough knowledge for the ArcView programme; lack of time and energy for carrying out all the tasks in appropriate level.

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GISAS: A PROJECT BORN OF A LONG-STANDING FRIENDSHIP AND THE TASTE FOR CHALLENGES

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"A Comenius friend is a friend for ever": this is just what the "GISAS adventure" essentially originates from: the seven Comenius partner schools decided to form another partnership because they did not feel like putting an end to their long common European experience. When we were introduced into the world of GIS, we immediately realized it was a big challenge but we had no hesitation in accepting it because we also understood the importance of being called as pilot schools, to help create in European upper secondary schools a new approach to Geography as a way of thinking in spatial terms; if the issue is a major one all over Europe, it is all the more so in Italy where this subject is not traditionally credited with the "dignity and status of a science". GIS provide the conditions to work the miracle, as even our school reformers seem to have become aware of. For Liceo Gobetti the challenge was a double one, as neither of us "official representatives" of the project was a geographer, but we both perceived that this geographical instrument could also affect and revolutionize almost the whole of our teaching activity. This article is meant to describe our itinerary into GISAS and its results.

Il Liceo Gobetti ha deciso di aderire al progetto Minerva GISAS prima di tutto per non interrompere una lunga esperienza di lavoro comune fra scuole partner europee nell'ambito del programma Socrates, e un'altrettanto lunga e preziosa amicizia; ma appena entrati nel mondo dei GIS abbiamo anche scoperto le enormi potenzialità di questi strumenti che sono in grado di rivoluzionare la didattica della geografia (e non solo), dandole quello "status definitivo di scienza" (Lodovisi Torresani, 1996, p. 295) che le è stato finora negato, e facendone valere la presenza "come insostituibile in tutto il percorso di formazione scolastica" (G. De Vecchis, AIIG [Associazione Italiana Insegnanti di Geografia]).
Il Liceo Gobetti – un Liceo Scientifico – è uno dei tipi di scuola secondaria superiore più "penalizzati" in questo senso, in quanto il suo curricolo prevede l'insegnamento della materia nel primo anno di corso, affidato al docente di Lettere ed una "pluri-geografia" (geografia fisica, geologia e astronomia) nel quinto, affidata al docente di Scienze. In entrambi i casi l'approccio alla disciplina è ancora di tipo prevalentemente nozionistico, non altamente motivante per gli studenti.
Tuttavia nella formulazione dei nuovi programmi della riforma scolastica in fase di attuazione, e grazie all'apporto determinante dell'AIIG, sembra verificarsi una netta inversione di tendenza che va decisamente nella direzione dei GIS: si parla di una "geografia che deve insegnare a "saper pensare lo spazio" attraverso la comprensione di […] processi e forme di organizzazione territoriale […] costruire un sistema di conoscenze organizzate, di competenze, capacità, grazie al quale lo studente "geografo" sia in grado di dare una soluzione a un certo problema con rilevanza spaziale, cioè leggere il territorio in modo autonomo e consapevole [..] promuovere la conoscenza di nuovi strumenti e metodi di rappresentazione dello spazio geografico fino dalla classe III della scuola secondaria di I grado" (dal testo della Riforma Moratti). E ancora si sottolinea la valenza trasversale della geografia, in quanto "si presta per sviluppare tematiche interdisciplinari [...]" (P. Battistini, L'École Valdotaine).
La realizzazione di tali obiettivi allude più o meno apertamente all'uso dei GIS e i geografi dell'AIIG ne spiegano i benefici: " il consueto impiego dei GIS a scuola renderebbe gli studenti soggetti attivi e partecipi, coinvolgendoli in un processo di ricerca-apprendimento nuovo e creativo […] aiutandoli anche a inserirsi nel mondo del lavoro…" (C.Pesaresi, La Geografia e i Sistemi Informativi Geografici, Atti del Convegno del Cinquantenario AIIG, 2004). Gli stessi geografi , tuttavia, mettono in evidenza le difficoltà nella realizzazione dell'obiettivo a causa a) della scarsa alfabetizzazione informatica dei docenti, b) della inadeguatezza delle risorse per l'acquisizione della strumentazione indispensabile.
Se l'università sta provvedendo a formare geografi professionisti e informatizzati, e quindi risolvere in prospettiva il primo problema, più complessa appare invece la questione delle risorse. Comunque, in scuole dove la

geografia è materia "professionalizzante" non mancano significativi esempi di lavoro con GIS e WEB GIS: accanto ad essi il nostro GISAS puo' presentarsi come un ulteriore contributo, che sarà sicuramente messo a disposizione sia delle scuole che dell'AIIG.

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Geographers by accident… roaming the streets of GIS

As mentioned in the opening abstract, our adventure starts in a somehow fortuitous way, and it is in some respects emblematic of a "rough path" grounded on the remote geographic university competences of Cristina Negroni – a teacher of English language and literature – and the even remoter secondary school ones of Sandro Favini, who teaches Maths and Physics; both of them with no background familiarity whatsoever with GPS or GIS.

The first approach to the whole matter was rather difficult. The theoretical training lessons during the meetings in Helsinki, however necessary and well-devised, were not able to "light us up", until we started working practically with the GPS and putting into practice the step-by-step instructions supplied by Tino Johansson, to use the ArcView programme. The "learn- while- doing" method, once more proved to be the most effective.

We had no difficulties at all, instead, with the water quality assessment, thanks to the previous experience with the Comenius project Water Solidarity, which had just in this area, as training in the use of the BISEL method, one of its strengths.

The problems we had to face as soon as we started, were both geographical (the GPS required the Map Datum, we had to deal with projections, plane and terrestrial coordinates, etc.), and informatic (raster and vector maps, georeferentiation, etc.).

To get explanations and expand on the subjects, we made use of Internet material, often from the Departments of Engineering or Architecture of Milan University or Milan Polytechnic, and professional advice from IGM – the Geographic Institution that makes maps at national level -, a department of Firenze University, or the Engineering Department of the Bagno a Ripoli municipality.

As we gradually reached the necessary confidence, the interest in the project increased and we got to realize that GIS at school could also be used outside Geography; in actual fact, wherever it might be useful or interesting to provide all sorts of information somehow connected with the territory.

As we firmly believe that to convey something successfully to students, it is necessary for the teacher to have very clear ideas on the the subject he/she is going to deal with, and to know its "critical" points as well, we decided to finalise the first stage of our work just to that, doing the various project tasks by ourselves, except for the field work, where collaboration was precious.

Later on, we tried out to teach what we had learned to a small group of six last year's students, who had a basic knowledge of cartography and some sort of familiarity with GPS. The first lessons were also attended by some colleagues who had decided to join the project. The students learned rather quickly how to use the GPS and the ArcView software, see figure 1.

The water sampling and analysis were as smooth as a sort of routine job, and in it our GIS "pioneers" – who already mastered the BISEL method –as successfully tried their hands at the chemical analysis with the Merck toolkit, see figure 2.

Figure 1. Students taking the coordinates of location 4 on the Arno, with GPS; the site is one of the recreational areas. Due studenti rilevano con il GPS le coordinate del punto 4 sull'Arno, in una delle aree ricreative).

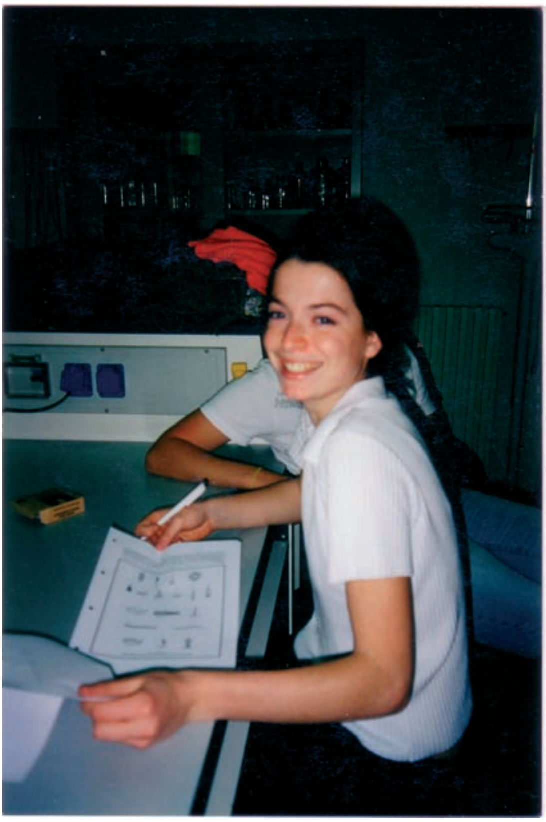


Figure 2. A student completing the BISEL analysis in the lab. Un'allieva completa l'analisi BISEL in laboratorio).

What made the whole moment of the water quality assessment new, however, was the fact that it was no longer a matter of collecting data as an end in itself; indeed, it was the starting point of a series of investigations aiming to justify their results. (It is probably interesting to mention the impossibiltiy we had to get to a biological analysis in the location on a tributary of the Arno, due to the total lack of macro-invertebrates; the students reported that to the Department of Environment of the local municipality, where they took measures to double-check the general situation of the river).

With the BISEL results the students created their first database and graph and then went enthusiastically through the steps of the project – which were also the answers to their queries -, showing no dislike for any of the subjects dealt with; so much so, that they accepted to do an extra-exercise with GIS. They were supposed to map the old people's homes in the territory of Bagno a Ripoli, their accomodating facilities, etc; the result was a study rich in data on the old people's population in the territory, their condition within the families and inside the mapped structures: all of that was visualized on a local map and through graphs. The work was published in the school review IL GOBETTI (May 2005) and successfully presented during the students' final examination; the latter circumstance being significant, as it can be read as an "intrusion" of GIS into the curriculum, since the students' presentation was in English and was accepted as an alternative to the traditional language exam.

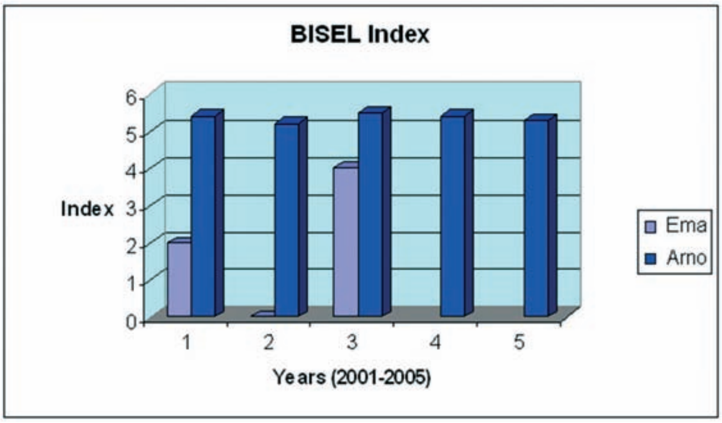
In the next stage of our GISAS teaching-learning activity we decided to involve a first year class. Given the group-age of participants and their background knowledge (previously tested), we resolved to proceed skipping the most difficult points, accepting intuitive meanings – however inexact they might be – of such terms as coordinates, Datum, etc. With these students, whom the GISAS work had been previously shown and explained to, we laid the foundations of a project that, starting from the location of their houses and one monument nearby, with the GPS, led them to position their data on the local map. The class's response will tell us if all that can have a future in the direction suggested by the Mayor of Bagno a Ripoli.

GISAS: ON THINKING IT OVER...

Now that we have got to the end of our itinerary, we can say that, in spite of its complexity, the experience has undoubtedly been a major one because it has opened a window on a new approach to teaching, which allows to go more thoroughly into the topics we have to deal with; but, more than that, we have seen with our own eyes the unconditional involvement it has produced in the students in a learning process that sees them active protagonists , capable of making up by themselves, through a logic sequence of queries, the stages of their researches, and of visualizing the results on maps and with graphs, thus showing immediate evidence of the competences acquired also in the handling of the not easy ArcView software, see figure 3. Not to say of the sense of citizenship and environmental consciousness it has awakened in them.

Besides, we cannot help pointing out the stimuli we teachers have received from the project to identify other areas than Geography, where GIS could be used, areas into which we even dared make a couple of "timid" incursions, as previously mentioned.

Therefore, we are persuaded that didactics with



Number	BISEL	Alkalinity	Ammonium	Hardness	Nitrate	Nitrite	Oxygen	pH	Phosphate	Temp	DDMMYY
1	------	10-7	0.3mg/l	6..5mmol/l	10mg/l	0.3mg/l	8.6mg/l	7	0.20mg/l	20°	12.10.2004
2	5	10-6.5	0.2mg/l	3mmol/l	15mg/l	0.4mg/l	7..5mg/l	7..5	1mg/l	2.5°	27.01.2005
3	5.5	10-6	2mg/l	2.6mmol/l	5mg/l	0..2mg/l	11mg/l	8	0.75mg/l	2.5°	27.01.05
4	5.6	10-6.5	1mg/l	3mmol/l	10mg/l	0..5mg/l	6..5mg/l	7..5	0..25mg/l	2°	27.01.2005

Figure 3. BISEL database and graph: the first autonomous achievement of two GISAS students. Database e grafico dei risultati BISEL: il primo prodotto autonomo di due studenti GISAS).

GIS will definitely have a future in our country - perhaps even sooner than we thought when in 2003 we accepted the dare of the GISAS project. On the other hand, this belief of ours is supported by what has been described in the abstract about Geography in our educational system's reform.

The curricula of some upper secondary schools will have to be changed, though, as from our experience it has turned out clearly that the greatest obstacle to the use of GIS in the present situation comes just from the desultoriness of the study of Geography in the curriculum of the Liceo type of secondary school. Presently, we only have the possibility of planning one-year projects, which, however, due to the complexity of the problems involved, prove to be difficult to carry out, also because of the limited number of hours available. To keep the topics lively and stimulating, finding a way of using GIS in other subjects, too, would help significantly.

At Liceo Gobetti the GISAS Minerva project has aroused curiosity and interest, but so far it has not involved our colleagues so deeply as to make them break away with the school's traditional project activities, in favour of a GIS experience (maybe that has to do with the general lack of informatic competences among teachers, hinted at in the previous paragraphs); whatever the reason, we have to say that in the course of the project's three years, practically all the colleagues that had joined GISAS – including those who should have been more directly interested in it – have given up. But something seems to get moving: at the end of the past school year, two Art teachers decided to participate in a project of territorial analysis in the Chianti area, which also implies the use of GIS: what if GISAS has started bearing fruit?

GISAS: WHAT HAS BEEN DONE TO DISSEMINATE IT

We must admit that due to an objective lack of time and unavoidable school involvements, we have made a "low-keyed" dissemination of the project, that is, without participating formally in any national or international events; locally, however, there are several institutions and associations where GISAS has been presented , rousing not only great interest but also availability to cooperate with us both when it came to finding the necessary maps and when we had our first approach to the ArcView software and its problematic areas. We cannot help mentioning the encouragement and support we got from the very beginning from the Department of Statistics of Firenze University, where the use of GIS has for a long time been a didactic instrument as well as a working tool in the ISTAT surveys, censuses, etc. they are entrusted with. It is just from this department that our first GISAS students obtained the material for a research on GIS at the University of Firenze, during a visit on GIS Day 2004.

As interested and cooperant have been the Environment and Town-planning Departments of Bagno a Ripoli municipality, as well as the Mayor himself, who proposed we worked jointly to the mapping with GIS of the municipality's Cultural Heritage, see figure 4.

GISAS is also known to the Military Geographic Institute, from which came an officer to hold a seminar at our school on the essentials of cartography; and to the Arno Basin Authority, where we have been formally asked to collaborate to the creation on their site of a Web Page devoted to schools.

An extensive official presentation was made to the new Headmistress – the second in the three years of GISAS - who wanted to get adequate information on the contents of the project and the practical achievement of its objectives; and one to the parents of the junior class we worked with in the past school year. At the moment we are starting to activate a network with the schools of the province of Firenze, to disseminate our work. The next targets of our dissemination will be the national Socrates Agency – and via them, the national Board of Education - , ESRI Italia, but, mostly the Italian Association of Geography Teachers, which we hope may become a reference point for all the teachers of this subject in the forthcoming reformed school: they will definitely help let GISAS have a future!

We cannot boast significant publications, partly because, as non-geographers, we are not able to say much more than what we learned when approaching GIS; we can just mention an article by Cristina Negroni – Lavorando coi GIS [working with GIS]

Figure 4. A student talking about GIS to the Mayor of Bagno a Ripoli during the presentation of the review IL GOBETTI (May 2005). Uno studente GISAS parla di GIS con il Sindaco di Bagno a Ripoli durante la presentazione della rivista "IL GOBETTI" (maggio 2005).

– in the review IL GOBETTI (May 2005), the article by Andrea Monti (a former Gobetti student) – Il Gobetti diventa pilota [Liceo Gobetti becomes a pilot school] - published in a local newspaper (June 2005), and finally the article An ideal lesson with GIS, by C.Negroni and S. Favini (June 2006), which, presently, is only available in our BSCW groupware – Bessie for friends.

Acknowledgments

Besides being grateful to Mr. Tino Johansson, who has brilliantly and patiently guided us in this itinerary, and the students who have been our companions and "guinea pigs" in the challenge, special acknowledgments are made to three people in particular who have proved decisive in getting us to move within the "brave new world" of Geography without getting lost in it: Mrs. Laura Grassini, professor of Business and Economic Statistics at Firenze University, who has been a great friend and the prime mover of our work, conveying to us her enthusiasm and her specific competences, ever so precious at all the stages of the project; Mr. Alberto Bizzarro, an architect from Bagno a Ripoli municipality, who provided us with the first maps, and also with the essentials to "relate" to them with the ArcView software; Mrs. Ann Johnson, ESRI Community College Manager, Higher Education, for giving us one morning of her time in Firenze, during which, with clear and effective words, she managed to remove once for all the "awe" that ArcView still roused in us.

And finally, thanks to Alberto Pietrini, who has been the official photographer of GISAS.

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An ideal GIS lesson at Liceo Gobetti, Italy

CRISTINA NEGRONI AND SANDRO FAVINI
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From the experience we have made in the past two years, we have got to the conclusion that a successful GIS lesson/series of lessons should differ according to the students' age-group; we started with a small group from a last year's class and went on with a first year's one, and we are positive that it did make a difference. With eighteen-year-old students the lessons can be prevailingly in the classroom/lab because the kids are likely to know already how to use a GPS, and to be familiar with water quality assessment – Bisel and chemical – and, with just one outing to the sampling points they will be able to collect enough information to answer the queries arising from the water quality results.

With younger students, instead, the approach has to be almost the opposite: lots of field work with GPS exercises, water sampling, and walks in the area of sampling points to observe the environment, and, back in the computer lab, practical activities with just the essentials of a theoretical information background. Nothing with these kids is to be taken for granted and their attention can be easily lost, even if the enthusiasm remains and there are no serious learning problems thanks to a genuine motivation.

We have chosen to describe an ideal series of lessons with a senior class, for our task, and the idea is that it might be on a line of continuity with what has been done so far in the project; it could be named *UPDATING GISAS*, the aim being to check if any/what changes have occurred in the quality of the environment of our original BISEL points.

With the type of students previously described, after briefly explaining what is meant by GIS and teaching Geography with them, the emphasis should firstly be put on the basic elements of cartography to make the learners aware of what is behind all the procedures to be followed to create a thematic map. Generally speaking, geography teachers in our country are seldom proper geographers and cartographers, so we would see a talk from an IGM expert (IGM is the Military Geographic Institute, which makes maps at a national level) as an effective propaedeutic lesson, through which the students could get familiar with what a map is, with different types of maps - raster and vector – and of projections, with different coordinate systems, etc. Immediately after that, the students would be taught how to use GPS, in connection with what they have just learnt about cartography: that would be a conscious geocaching activity to the GISAS sampling points, soon followed by field and lab work guided by the Chemistry and Biology teacher on new samples, to update the assessment of the water quality. The next stage would be opening the ArcView programme, and after an overall description of the same, start visualising the sampling points on a new local map, on the basis of their geographical coordinates.

The ArcView GIS software and the variety of opportunities it offers to carry out a thorough survey of the territory through the data collected in the analysis points should be the second focus of attention of our lesson/s. To do so, the students would be shown our GISAS map layers, as well as the Web Atlas, and then asked to go through a few chapters of Tino Johansson's step-by-step instructions with us, to learn together how to create their new map layers. After that, the class would be divided into small groups with different tasks to be done on their own, just making use of the Italian version of the above mentioned instructions. At the end of this work – to be done in a couple of weeks – one student for each group will have to report on the task they had been assigned mostly by showing us what the new maps and database created, look like. At this point plenty of time should be devoted to the comparison of data; particularly if there have been significant changes in the pollution levels, and the inevitable effects on the environment. Last but not least, we would have a general discussion, and the students would be encouraged to suggest what else, in their opinion, could be done with an instrument like GIS, and what other subjects could be involved in such an innovative teaching methodology.

Part of what has so far been described mirrors the actual work we did with our GISAS "pioneers"; the rest is what would add the touch of "ideal", but a realistic ideal, because we teachers would no longer be "learners with the learners", with all the perplexities and uncertainties that such a role initially implied. The only perplexity left is – as often happens with long-standing projects – the contribution of colleagues; in actual fact in the course of our GISAS we have gradually lost it, as the most active cooperator – the Science teacher – has been moved to another school, and the rest have got involved in other extra-curricular activities and have confined their collaboration just to some help in the field activities.

We won't give up, though, and do hope that the Summer holidays and the Sm@k week in Geel in September will give us new energies and enthusiasm capable of involving new "labour" to put all of this into practice in the classroom and to carry on the the delicate task of dissemination!

Figure 1. A group of upper secondary school students carrying out the GISAS project exercises and learning with GIS in Geel, Belgium. Photo: Manuella Borghs 2006.

Implementation and use of GIS in academic context at Széchényi Ferenc Középiskola

BORIÁN GYÖRGY
Széchényi Ferenc Középiskola, Barcs, Hungary

Geographical Information Systems (GIS) have not yet been used in general secondary school education in Hungary. Only eight schools specialising in surveying have purchased GIS software which are used in technical subjects. Due to the GISAS project the Széchényi Ferenc Középiskola is the first grammar school that has bought GIS software for use in academic subjects in Hungary. Therefore the school is in a special situation as there are no available education materials. This article gives a brief introduction to this pilot project and reports its results from the first few years.

A térinformatika, azaz a Földrajzi Információs Rendszerek (Geographical Information Systems - GIS) használatát még nem oktatják Magyarországon a középiskolákban. Mindössze nyolc, földméréssel foglalkozó szakközépiskola vásárolt térinformatikai szoftvereket, melyeket műszaki tantárgyak keretében használnak. A GISAS projektnek köszönhetően a Széchényi Ferenc Középiskola az első olyan középiskola Magyarországon, amely közismereti tantárgyak oktatásához vásárolt térinfomatikai szoftvert (ArcView 8.3.). Mivel nincsenek magyar középiskolai térinformatikai oktatási anyagok, ezért az iskola úttörő szerepre vállalkozott. Ez a cikk röviden beszámol a projekt első éveiről, és ismerteti az elért eredményeket.

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Introduction

At the moment, GIS is not mentioned in the Hungarian national curriculum. As far as I know GIS is not taught in general secondary schools. Unfortunately, the Hungarian curriculum is very dense. There is only a little time to deal with topics which are not in the official curriculum, like GIS. Therefore GIS can be used only in one or two lessons a week during the school-year or it can be used in out-of-school activities.

However, due to the dissemination activity of the Széchényi Ferenc Középiskola and the GREEN Pannónia Foundation (the main office is in the school) some committed teachers have started to use GIS in different subjects, mainly in geography, biology and environmental education.

The Széchényi Ferenc Középiskola is a general secondary school with a faculty of economics. In addition, great stress is put on the modern language education. (English, German, Italian, French) About 500 students attend the school and 45 teachers work fulltime.

In the school-year of 2004/05, GIS was used in the geography student circle led by Mr. Palotai Zoltán. There was only one lesson per week when students could use the GIS software (ArcView 8.3) and the instruments (GPS receivers) with a teacher.

In the school-year of 2005/06, the school provided two lessons per week for those 10 students who were very interested in the GIS. (Some of these students would like to continue their studies in connection with GIS.) These lessons were held by the author in the computer room of the school on Wednesday afternoons. During these lessons the students thoroughly studied the use of ArcView 3.2 and 8.3 software and they used the GPS receivers. In 2006, we used the GISAS manual and we followed its instructions. The students started to measure the water quality of the Györgyös creek in the National Park. Two students (Oláh Júlia and Nagy Szabolcs) gave an excellent presentation at the 11th. BISEL Congress (June 3, 2006, Budapest) about their GIS activity. They presented some good examples of the use of digital maps in the Hungarian BISEL programme and they showed the participants how to place these digital maps on the BISEL website.

GISAS project activities in the Széchényi Ferenc Középiskola

Year 2004

In 2004, the school continued its activity in the Hungarian BISEL network. (The students started to measure the water quality of the Rinya creek in 1999.) However, this year we used GPS receivers for the first time to measure the coordinates of the sampling places and these coordinates can be seen on the BISEL website. The members of the geography club placed these sampling points on the digital map which was purchased in the frame of GISAS project. (The water quality of the Rinya creek can be seen on the BISEL website: www.bisel.hu / projects)

In October 2004, the school organized a two-day training for teachers with the help of the ESRI Hungary in the school. All the interested teachers (geography, history, biology, language, physics and sport teachers) took part in that introductory training where digital maps and GPS receivers were used.

We celebrated the international GIS day in 2004. In the hall of the school the author and some students presented GIS and the GISAS project to the school in four lessons. During these lessons almost 400 students learned about the project and many of them could use the GPS receivers in the school garden.

Year 2005

During 2005, the Széchényi Ferenc Középiskola and the Danube-Drava National Park had some common projects. The students of the school measured the coordinates of the campsites of the National Park along the Drava river. The National Park sent these coordinates to the visiting tourists.

An other common project was the “Where do the black storks live?”. Borián Csilla (13y student) together with Mr. Csór Sándor, a ranger of the National Park measured the coordinates of five nests of black storks living in a small protected area (Csokonyavisonta meadow). She made a study of the nesting customs of black storks by using the GIS. This study was published in the national newspaper called “Természetbúvár”.

The students of the school actively participated in creating a bike route between Barcs and Drávatamási. They used GPS receivers to find the best route and they made a digital map of the final route.

Year 2006

In May 2006, the author and some students of the Középiskola made a survey (measured the coordinates of fire hydrants above and under the ground in the town and visualized on a digital map) for the Fire Brigade of Barcs town. This study was presented in the headquarter of the Fire Brigade.

The students of the GIS club started to measure another creek in the National Park. The Györgyös creek is a tributary of the Rinya creek and it flows in front of the centre of the National Park. These results were directly placed on the BISEL website. They presented this activity in the 11th BISEL Congress in Budapest.

In the spring of 2006, the Széchényi Ferenc Középiskola joined the South Transdanubian White Stork project. (This project is financed by the Ciconia Foundation, Lichtenstein and coordinated by the Danube-Drava National Park.) The school provided the GPS receivers to the other three participating schools to measure the coordinates of the nests. The students of the GIS club put this data on digital maps.

GISAS Manual

The Manual is very useful as it shows the use of the ArcView 8.3 step by step on the same digital map. At the beginning, the English language caused some problems but later it became easier and easier. Our students liked to work on the ‘Recreational areas’ and the ‘Animal habitat’ layers. However, they had problems with the ‘Sewers’ and ‘Soil types’ layers. These themes are more complicated (specific information is needed) and a little bit boring for them.

We realised that the use of GPS was always a great success. Everybody enjoyed seeing his own position on the screen or the track he saved on the receivers. In addition, it was always very interesting (and motivating) to see the saved tracks and waypoints on the digital maps!

GISAS in-service training

The GISAS in-service trainings were, of course, very useful. Without these training sessions we could not have started our work with the ArcView 8.3. However, I think more practice would have made our life easier. During the meetings there were too many theoretical explanations without using computers. But I have to mention that Mr. George Dailey's and Mr. Joop van der Schee's presentations always gave an impetus to my GIS activity.

In addition to the personal meetings, the most valuable parts of the GISAS project were the e-learning homework. The information was always very precise, so I never had any problem with them.

I would like to reflect on the 'Bessie' (BSCW groupware): in the beginning it was absolutely clear but after the changes using of it became a little bit difficult. I missed a system in the directories, files and theme. At the end of the project there were so many directories, files on it that sometimes I couldn't find the proper file.

Reflections on the GISAS project

No doubt, that GISAS project has given a lot of opportunities to the Széchényi Ferenc Középiskola in the last three years. Teachers and students were invited to different meetings, congresses to present the GISAS project. There were a lot of very good articles about these activities in the regional newspaper. These promotional events helped the teachers and students involved to get all kind of support from the headmaster.

I would like to emphasize that the successful introduction of the GIS in the Széchényi Ferenc Középiskola is mainly due to the commitment of the headmaster and some teachers to the student-centered education methods. They recognized that GIS is very useful tool to motivate students to carry out scientific work on their own.

We are convinced that the GIS afternoon lessons were the biggest success in our GISAS activities in the Széchényi Ferenc Középiskola. We hope that we can continue these lessons in the next school year, too.

The biggest obstacle of the project was always the lack of time. Teachers and students in Hungary are overloaded. In addition, due to the Hungarian education system they have to concentrate on academic subjects as these results are taken into consideration in the further studies of the students. These circumstances mean that it is impossible to find any period which fits into every interested student's timetable. The possible solutions could be; building the GIS into the official timetable of one of the classes or to find or train more teachers who could deal with the interested students in their free time.

However, the students and teachers know that GIS is more and more important in many fields of life (mobile phones, sport activities, vehicles, etc). Therefore, we are facing to an increasing demand for learning more about the GIS.

Another problem is the lack of computer rooms. The computer rooms during the lesson period are always full with computer science and informatics lessons, so it is hard to get into these rooms during e.g. a geography lesson. Teachers have to change lessons, etc. to use GIS in an academic lesson.

I have to mention that the complexity is one of the biggest attractions of the GIS activities. The students have to deal with at least geography, English language and some special scientific area (eg. biology or history) in addition to the computer science. Moreover, any kind of GIS activity is project work, since they have to plan, organize and carry out fieldwork.

In our experience the selection of a good, interesting GIS theme is half the success in a GIS project. The digital maps, the GPS receivers are always attractive for those students (mainly boys) who like computers but a good theme can attract a lot of other students who would like to do some research work.

After three years of using GIS in general education the Hungarian participants of the GISAS project are

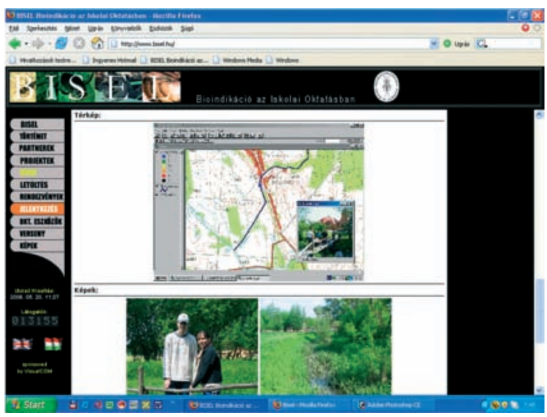

Figure 1. The screen of the Széchényi Ferenc Középiskola's projects on the Hungarian BISEL website (Nagy Szabolcs and Oláh Júlia measured the Györgyös creek and they put the results on a digital map).

1. kép. A Széchényi Ferenc Középiskola projektjeinek oldala a BISEL honlapon (Nagy Szabolcs és Oláh Júlia tanulók a Györgyös-patak vízminőségét vizsgálták és az eredményeket megjelenítették egy digitális térképen).

convinced that the GIS could be used very well in academic subjects. Eg. in biology: the habitats of species, in literature: the birthplaces of famous authors, in history: the changes of the country, in geography: meandering of the rivers, in sport education: forest walking trails or forest bike routes can be visualized on digital maps. By using GIS the school can carry out a lot of community work for the town, as well. (eg. measuring the coordinates of illegal landfills and putting them on a digital map)

It is also interesting to mention that there were no significant differences between boys and girls in using GIS. Maybe, we can say that boys were interested more in the technical problems while girls were motivated a little bit more in the field work. But during the projects we realised that both boys and girls were very active.

GIS project: finding the best cycling route

One of the most interesting activities was the signposting the cycling route between Barcs and Drávatamási. The Education centre of the National Park in Drávatamási is a popular place for tourists, especially for the increasing number of cyclists. Unfortunately, the normal road between the two settlements is full of heavy traffic, so it is not safe for cyclists. Therefore, there was a great demand to find a route through the forests. Some students of the school tried to find the best route by using GPS receivers. They showed the possible routes on the digital map. Finally the route was illustrated on the digital map, see figure 2.

Dissemination and networking of the GISAS project

The Széchényi Ferenc Középiskola made great efforts to disseminate the results of the GISAS project in the school, in the region and in the whole country.

Year 2004

In October 2004, we organized a two-day training seminar for the teachers with the help of the ESRI Hungary in the school. All the interested teachers (geography, history, biology, language, physics teachers) took part in that introductory training seminar.

We celebrated the international GIS day in 2004. In the hall of the school the author and some students presented the GIS and the GISAS project to the school in four lessons. During these lessons almost 400 students learned about the project and many of

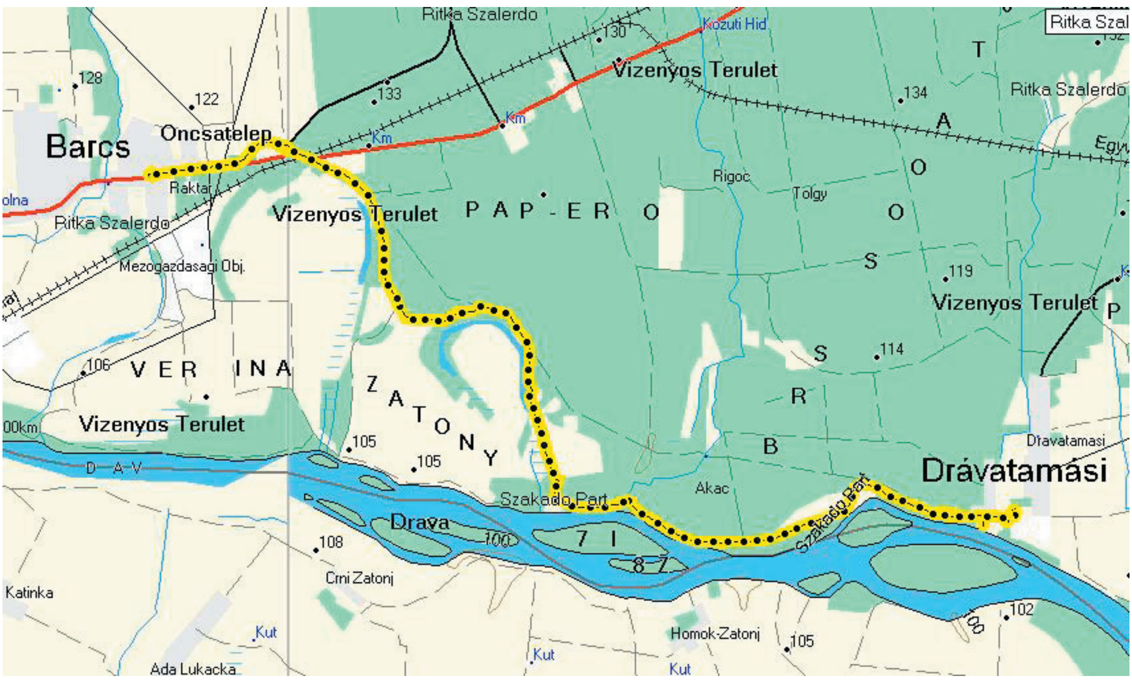

Figure 2. A cycling route created by the students with the help of GPS.

them could use the GPS receivers in the school garden.

We were invited to Teply Vrch (Slovakia) by the Slovakian Environmental Agency where we introduced the use of GPS to Slovakian teachers and environmental educators of National Parks.

Year 2005

The teachers of the Széchényi Ferenc Középiskola took part in three teacher training seminars organised by the Hungarian BISEL network. During these seminars we introduced the GIS and the GISAS project to the participating teachers. (Approx.110 teachers took part in these three seminars.) We used digital maps of the relevant areas and we used the GPS receivers to measure the coordinates of the sampling places of the exercise, see figure 3. One of the seminars (in Túristvándi) was financed by the TAIEX, Brussels (www.bisel.hu).

The Széchényi Ferenc Középiskola introduced the GISAS project to the participants of two EU Comenius school projects. In May 2005, the participants of the "Small is beautiful" Comenius school development project and in September the participants of the "Home Green Home" Comenius project organized project meetings in Barcs. The teachers of the Széchényi Középiskola introduced the GIS to these groups.

Figure 3. The Hungarian teachers are learning to locate points with GPS receivers. Photo: György Borián 2005.

Year 2006

The Széchényi Ferenc Középiskola and the GREEN Pannónia Foundation organized a Leonardo project (Bioindication and GIS in the environmental education – BioGIS2005) in Belgium for 40 Hungarian teachers and environmental educators. During the three preparatory training sessions in Budapest and two-week course in Belgium the Hungarian participants learned a lot about the GIS and the use of GIS in general education. (www.biogis2005.uw.hu) During the course we worked together with the Sint-Dimpna Lyceum, another member of the GISAS project.

In May 2006, the BISEL network again organized a teacher training course with the financial help of the TAIEX. The organizers invited Mr Tino Johansson, the coordinator and Mr. Joop van der Schee, the evaluator of the GISAS project. They gave very interesting presentations about the GISAS project and the use of GIS in education to the 45 Hungarian participants.

Acknowledgements

I would like express my sincere gratitude to Ms Hegedűs Tünde and Mr Szabó Péter (+2005) for their outstanding support they have provided through the years to enable the GISAS project to be implemented in Hungary.

I would like to recognize the following professionals for reviewing ad providing valuable comments on this study: Mr Palotai Zoltán and Jonathan Conway teachers of the Széchényi Ferenc Középiskola.

I would like to acknowledge the entire Széchényi Ferenc Középiskola staff for their enduring commitment to implement GIS in academic education.

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GISAS project in Greece

GEORGIA KAKARDAKI & PERIKLIS KAMARIS
2nd Lyceum of Larissa, Greece

Our involvement in European Projects started in 1997 with a Comenius program "Rivers, Culture and Co-operation" and it finished in 2000. We went on with another one "Water Solidarity" until 2003. Our next involvement to the Minerva GISAS project was an interesting continuity which gave us the opportunity to develop our experience and knowledge on the water quality issues in relation with GIS. Geographical Information Systems (GIS) have not been used in secondary school geography education in Greece at all. Geography is taught in the Greek Gymnasium in the 1st and 2nd class. The geography curriculum is changing from the next year 2007-2008 but GIS isn't mentioned at all. Of course GIS is a subject in the Greek universities at the related departments. Also GIS is used by an increasing number of state services related to agriculture, topographical subjects, properties, etc. The teachers of geography are not specialized in the subject and are also unfamiliar with GIS. Our participation in the GISAS project was an opportunity for us, our colleagues and for our pupils to have an experience on what happens in the frontier of geography education in Europe and in educational research. The following reference is a brief description of the activities with the GISAS project at our school and reflections for the future.

Περίληψη στα Ελληνικά
Η συμμετοχή μας στα ευρωπαϊκά προγράμματα άρχισε το 1997 με ένα πρόγραμμα Comenius «Ποτάμια , Πολιτισμός και Συνεργασία» το οποίο ολοκληρώθηκε το 2000. Συνεχίσαμε με ένα άλλο πρόγραμμα Comenius «Νερό και αλληλεγγύη» έως το 2003.
Η επόμενή μας συμμετοχή στο πρόγραμμα Minerva GISAS ήταν μια ενδιαφέρουσα συνέχεια που μας έδωσε την ευκαιρία να αξιοποιήσουμε την εμπειρία μας και τις γνώσεις σε θέματα ποιότητας νερού σε σχέση με τα Γεωγραφικά Συστήματα Πληροφοριών. Τα ΓΣΠ (GIS) δεν χρησιμοποιούνται στην γεωγραφία στην δευτεροβάθμια εκπαίδευση στην Ελλάδα καθόλου. Το μάθημα της Γεωγραφίας διδάσκεται στην Α και Β τάξη του Γυμνασίου . Το αναλυτικό πρόγραμμα του μαθήματος της Γεωγραφίας αλλάζει από την επόμενη σχολική χρονιά 2007-08 αλλά τα ΓΣΠ δεν αναφέρονται καθόλου. Φυσικά τα ΓΣΠ είναι ένα αντικείμενο στα Ελληνικά πανεπιστήμια και σε σχετικές Σχολές .Επίσης τα ΓΣΠ είναι σε χρήση σε ένα αυξανόμενο αριθμό δημοσίων υπηρεσιών που έχουν σχέση με την γεωργία, τοπογραφικά θέματα, ιδιοκτησίες κλπ. Οι διδάσκοντες γεωγραφία δεν είναι ειδικευμένοι στο μάθημα και δεν είναι εξοικειωμένοι με τα ΓΣΠ. Η συμμετοχή μας στο πρόγραμμα GISAS ήταν μια ευκαιρία για μας , για τους συναδέλφους μας, για τους μαθητές μας να αποκτήσουμε εμπειρία πάνω στο τι συμβαίνει στο μέτωπο της εκπαίδευσης στην γεωγραφία στη Ευρώπη και στην εκπαιδευτική έρευνα. Η ακόλουθη αναφορά είναι μια σύντομη περιγραφή των δραστηριοτήτων με το πρόγραμμα GISAS στο σχολείο μας και οι αντανακλάσεις για το μέλλον.

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Introduction

Our school is situated in one of the most central quarters in Larissa. It is a school of 550 students with 260 boys and 290 girls. The average of students per class section is about 25 students. Both in the B' and C class, courses of all types are taught: theoretical, positive (science) and technological respectively. It consists of 50 teachers, 45 teachers constitute the permanent and 5 or more teachers are on temporary assignment and teach subjects of choice like: music, design, French as a second foreign language. The courses start on 10th of September and stop on 30th of May. The school year is divided in 2 four-month periods. The first term is from September to January and the second term is from February to May. June is the month of exams.

Trough out the year there are two periods of holidays: 15 days at Christmas and 15 days during Easter holidays.

A. The theoretical direction includes subjects like Ancient Hellenic- Latin – Philosophy - History
B. The positive (science) direction includes subjects like Maths-Physics-Chemistry-Biology
C. The technological direction includes subjects like Maths-Physics-Chemistry-Technology of communications, principles of organization and business administration.

All students of 2nd and 3rd class except the subjects of the direction they attend some subjects of general education like Hellenic Language-Hellenic literature-Religion-History-Foreign languages.

After stating the detailed curriculum, it is obvious that GIS and environmental education are almost non-existent, in our national curriculum. All our efforts to involve students to such projects were in an amateurish and researching level. The only motive for pupils to join such projects was the pupils' exchanges. The question is then is it worth it and the answer is yes. We really believe that the exchange programs have contributed to learning more about our national differences, and to increase transnational understanding, especially of the common European heritage.

In GISAS project GIS enabled us to broaden our life experience, to train to communicate mostly in English of course, but also with other means, to train social competence, a quality more and more demanded in the labor market.

However, we hope in the close future our ministry of Education, due to the new challenges and regulations will take it seriously and introduce and apply GIS to our schools. New methods and techniques are applied on many sections, why not on education. Besides, it's a modern way of learning and exchanging information.

GISAS project activities

Since this project has started a lot of several activities have taken place at our school. First of all the method of BISEL for the water analysis and assessment. Pupils enjoyed very much doing this field work because it combined enjoyment being near the river and learning at the same time through cooperation and action.

The teachers were involved in the project with a group of ten pupils who participated in the activities of using GIS, GPS and digital maps at our school. Our opinion is that the exercise manual and the ArcView tasks were very useful and instructive. They help us to understand all about GIS operations step by step. The learning process was slow but a steady one. Our pupils liked very much working outside, especially when they had to collect water samples to analyze them to use the GPS device to spot locations on the map. What they didn't find very interesting was the work in the classroom with ArcView, maybe because they aren't so familiar to this way of working and learning.

The main difficulties for teachers during the project were the new terms and meanings of a new subject, like GIS, and the use of the software.

From the very beginning of the project, the first thing we did was to install the software. After Helsinki meeting and the first training by Tino, we organized a seminar at our school offered by MARATHON DATA the ESRI representative in Greece on the use of ArcView.

In our effort to find users of ArcView and local digital maps, we got in touch with the Topographical Department of Municipality of Larissa. However, they couldn't help us a lot because they didn't use this software and digital maps weren't available for the public. Finally we scanned a printed local map and with the help of the Slovenian partners we found a solution.

The next step was to form a group of ten pupils and training them in the series of exercises made by Tino. Of course we met some difficulties due to the fact that ArcView was a new and complicated software and all these activities are not included in the curriculum, so we had to find free time in the afternoon, for both pupils and teachers, to deal with the project.

An interesting part of our activities was the training and practicing of the use of GPS. We took the coordinates of different points of the town and the sampling points of the river Pinios.

Then we asked the contribution of some colleagues, who were involved in the previous Comenius projects relevant to water quality assessment and BISEL analysis, especially from Mr Leonidas Zioulis (teacher of chemistry). We used the chemical analysis kit and wrote down the results.

It was a surprise that we didn't find any pollution in our river waters, although it is widely accepted that the river is polluted. We discussed a lot about the possible reasons. Finally we concluded that the main factor was that we did sampling in January when the

Figure 1. Pupils during water sampling .
Εικόνα 1. Μαθητές σε δειγματοληψία νερού

amount of the water flowing in the riwer is big. The second factor was that during previous months there wasn't any agricultural activity on the fields near the river and as a result we didn't find any fertilizers and pesticides.

In the context of these discussions, we referred to the different types of the rivers we meet in Europe. For example the northern rivers (e.g. Scandinavian) are short in length and with a big amount of water, the central European rivers are very long and they collect the pollution of many countries. The Southern rivers are short in length and the amount of water depends on the season. All these characteristics affect the pollution of the river water.

Reflections on the GISAS project

Under these conditions in our education the use of GIS seems to be difficult. We have a chance to use the GIS software in the context of environmental education, given that it is a non-obligatory subject and more flexible in the issues of studying and the school timetable. So we could plan field work, laboratory work, excursions depending on the interests of teachers and pupils. We also could develop national or international cooperation with schools of similar interests, meaning a kind of motivation for our pupils and dissemination too.

Dissemination and networking in the GISAS project

We had some publications to our local newspapers which is the biggest in our prefecture, during GISAS meeting in Larissa. The publication, except of

Figure 2. Students working with ArcView.
Εικόνα 2. Μαθητές εργαζόμενοι στο ArcView.

the event and the participants, referred to the introduction of GIS in the teaching of Geography in the secondary school education. We also had a good collaboration with our local water service and the staff who were very willing to help us in any kind of information and elements we needed. We also have to mention that a lot of our colleagues were prompted to find ways to apply the GIS software in their own subjects.

Acknowledgements

We would like to thank all the persons who helped us to carry out this project in one or the other way:

First we would like to thank our Headmaster Mr. Christos Christonis and some of our colleagues who helped and supported us. The staff of the municipality

Figure 3. Teacher training.
Εικόνα 3. Εκπαίδευση εκπαιδευτικών.

services who tried to help us. Many thanks to the manager and the staff of our local water service. Also many thanks to the Manager of Marathon Data Systems the Greek ESRI representative for his willing to offer us a training course in our school.

The local newspaper ELEFHTERIA for the publicity and the dissemination of our activities

Last but not the least, special thanks to our project manager, Mr. Tino Johansson, for his precious instructions and continuous presence and help whenever we met any kind of difficulties and obstacles in the process of our project.

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GISAS project in Sweden

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Our school has been cooperating with seven other European schools in two different EU Comenius projects during 1997-2003, dealing with activities related to water and our local rivers. When we were offered this Minerva project it was a natural follow up to our former work. For me as a Geography teacher with strong interest in environmental issues it was a very interesting project, especially as I am also teaching computer related subjects at school. My colleague Mrs Ulla Dahlström also supported the idea of prolonging our cooperation. I have used GIS software in the middle of the 1990´s, but there was very little support and material to work with and the software was limited. This project offered us the opportunity to use high quality software along with well known measurement methods like the BISEL and also very important, with well known partners. This article is a brief description of the work with the GISAS project at our school and reflections for the future.

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Background

Torsbergsgymnasiet is an upper secondary school with 1 100 students in the city of Bollnäs, 300 km north of Stockholm. We have most of the national programs and I work in the Social Science Programme, a theoretical 3 year program offering Economics, Culture, Social Science and Languages specializations. I am head of the Geographical institution and Ulla Dahlström is head of the Social Science institution.

In the Swedish curriculum, Geography is the only subject where GIS is mentioned in the syllabus and the Social Science program is the only program where Geography is a subject! However the concept GIS is not mentioned, you can read a quotation from the syllabus below:
”develop the ability to formulate and analyse problems concerning local and global survival and environmental issues, and identify and argue for ethical standpoints, develop the ability to work with maps and other geographical information, collect, assess and process material, draw conclusions and generalise, present in writing and orally, and explain as well as provide the reasons for their thinking and conclusions.” [1]

In the proposal for the new curriculum for the upper secondary schools 2007, Geography was taken away as a compulsory subject. Fortunately this was changed in the final version.

There are two levels of Geography, level A is compulsory and level B is for the Social Science specialization. GIS is part of the syllabus for both. There are no demands on field studies or use of software or GPS, only that GIS should be described and exemplified. For level A, before the start of this project, I let the students use a GPS and computer software to find the shortest route, showed them digital maps and how they could be used for environmental research and explained how GIS can be used in society. We also studied the GIS text in the Geography school book[2]. Level B had less of practical GIS exercises than the level A Geography course but still some text in the Geography school book[3].

Some ten years ago I also used Swedish GIS software[4] but there were technical problems using it in the local network and the number of good exercises was limited. The software was only used in schools and data from outside sources was difficult to use. I gave up using it after some years.

We have good contacts with the different

[1] From English website Skolverket, the National Bord of Education in Sweden http://www3.skolverket.se/ki03/front.aspx?sprak=EN&ar=0506&infotyp=8&skolform=21&id=GE&extraId=
[2] Östman P, Barrefors O, Luksepp K. (2001) Geografi A+B Vad är GIS 21-25
[3] Östman P, Barrefors O, Luksepp K. (2001) Geografi A+B Planering med GIS 361 -369
[4] “PC Atlasen GIS” published by SNA, Sveriges National Atlas

departments of the city council, specially the Department for Planning and Construction. They have supported us with local maps and we are always welcome to do study visits.

Obstacles

When this project started I felt rather safe, being the only Geography teacher with at least some experience from GIS software. The BISEL measurements were also easy to make due to the experiences from earlier projects. But in the early stage of the project there were many obstacles such as problems to learn the new software, getting a good digital map and the process of deciding what different layers to create.

The software, ArcView 8, was not so easy to learn as I had expected. We first got an old version, ArcView 3, but the differences were significant and it was no big help starting with version 3. My own philosophy when it comes to learning new software is "trial and error"; I don't like manuals. Of course the best is to ask someone who knows the software but unfortunately no one at school had that knowledge. My rescuer was Mr Martin Blixt at the local municipality. He had a three year employment as GIS-coordinator in the municipality and academic degrees in GIS. He has helped me a lot with the program and maps and the benefit was mutual as he was glad to be able to practice a newer version of the ArcView software. The municipality uses a local Cad-program and MapInfo[5] but with the latest versions of the software it is rather easy to transform a MapInfo file to an ArcView file. Martin taught me a lot of basic GIS terminology and showed me how to find help on the Internet. We also solved a lot of problems connected with Windows XP and working in a local network. When the students logged in, they were not authorised to use the GIS software without a lot of changes in the local computers.

Getting digital maps have been a problem in many of our partner schools. Our map problems have been minor but never the less it did take a lot of time. The municipality had their own digital maps which we were free to use but we had to decide what colours to use for different types of areas. We tried to find out the official Swedish colours but did some adjustments to make it look better. We found out that every country more or less had their own set of colours, for example the colour for forest could be green of various shades but also white in some countries. Maybe this could be something for the EU to harmonise. I also remember we had trouble to find the symbol for railway in the ESRI Internet database together with some other symbols.

The next problem was to transform the map from RT 90[6] to WGS 84[7]. First we had problems with the school's old GPS and then difficulties to transform the map into WGS 84 in ArcView. The map was sheared[8] and we tried all ways of solving this problem. When asking experts at ESRI Sweden they told us that it was difficult to do and that we just had to accept the shearing. We later found out that all the other partners maps had this distortion, the higher latitude the bigger distortion.

Each partner school should be responsible for one layer apart from the BISEL-layer and the local map. This caused some problems in the beginning as we had to specify the criteria in a way that it would not cause any obscurity and it would be applicable in all countries. We only met two times a year and the meetings were very tight and sometimes we didn't realise the practical problems we would face when we started to work with a new layer. Then Tino[9] was the

Figure 1. Torbjörn Larsson to the right, with four of the first GISAS students outside Torsbergsgymnasiet.

[5] MapInfo is a commercial GIS software similar to ArcView
[6] RT 90 is the official Swedish coordinate system for maps
[7] WGS 84 is the European standard coordinate system we all were ask to use
[8] It was rhombic instead of rectangular
[9] Mr Tino Johansson, coordinator of GISAS project at the University of Helsinki, Finland

one who had to make all corrections and send them via BESSIE.

Activities

The field work with the GPS and the water analyse measurements were easy to do when you had a group of students and the time to do it. We solved this in a very practical way at our school. The year three students have to do an "Exam Project" to be finished in April their last school year. This should be some sort of research and presented as a formal academic paper. We found five students who wanted to do this GISAS project as their "Exam Work". Together we planned where the measurement points should be and practiced how to use the analyse equipment. We produced an analysis protocol and started to work with ArcView. They started in April 2004, their year two and did most of the measurements themselves as they had access to their own car. This was a necessity because our six points of measurement were spread many kilometres from each other. One complication with the analyses is the climate in Sweden – we had to do the spring testing late in May and this is normally a very hectic time for both students and teachers. We also found out that the autumn testing gave more or less the same values for all testing places.

This first group of students was very active and enthusiastic. They divided the work among themselves; one was the ArcView expert, one was the BISEL-index expert, one was the GPS expert, one was the chemical analyses expert and one was the media expert. The last mentioned produced videos, took photos, made Power point presentations and coordinated much of the work. They produced a very nice and entertaining CD and their exam paper was good. They also attended year one geography classes where they made PowerPoint presentations explaining GPS, GIS, the GISAS-project, BISEL index and chemical analyses.

Myrbäcken is the Swedish name of our local river. It is a stream coming from the forest running through agricultural areas and an old city dump and then through Bollnäs, passing outside our school into Vågen, a small bay of the much bigger Ljusnan river. We hoped to see some interesting changes in the analyse result for the six measurement places but to be

Figure 2. Myrbäcken just downstream city dump. Photo: Torbjörn Larsson 2006.

honest, it was very difficult to see any changes in the water quality that could be related to the surrounding environment. On the contrary the best BISEL-index, 9, was just downstream the old city dump, the place where we thought the negative environmental influence would be most probable. Finding obvious environmental effects was of course bonus, the most important outcome of the project was to learn how to use the GPS and ArcView.

Spring 2005 the five students graduated and we were lucky to find three new students, taking over the project. They did all the analyses and again one of the students concentrated on the ArcView software, one did research of the flora and fauna along the river and one made some cultural inquiries of the use of the river in the past. They also found some environmental effects – Myrbäcken flows into the bay Vågen which some summers is affected by flowering algae. This is very disturbing for people living close to the bay and the cause is probably the leak of phosphates from the agricultural activities along Myrbäcken.

They produced a DVD, a folder, made a statistical inquiry in a class[10], made PowerPoint presentations in different classes, helped me with ArcView lessons and made the exam paper. The help from the two groups of students together with the help from Mr Martin Blixt has been crucial for the outcome of the GISAS project.

The year one geography classes were all visited by the GISAS students with their folders, PowerPoint and CD presentations. This was a very good complement to my basic education about GIS. The second GISAS group also made an enquiry[11] in one class about what

[10] See next page about "Mapping our world" in class S3.
[11] See appendix page

had been best, the folder, the PowerPoint presentation or the CD. The result was roughly that the folder gave them the most facts and that the CD was most entertaining.

The year two geography class[12] was involved in another international project "EcoCultural Tourism[13]". Mrs Ulla Dahlström and I worked with this project together and the task was to produce some sort of presentation of local places of tourist interest. We decided to make two folders[14] and one brochure[15] and when editing them, we used ArcView to produce all maps and symbols needed. This was a good and useful way to introduce ArcView in the class. We started to edit the whole folder in ArcView but this was too much for our old computers. We also had some problems working in our network – if we moved an ArcView file to a different folder all connections to pictures and symbols were destroyed.

For the year three geography class[16] in witch the three GISAS students attended, Mr Blixt and I planned a series of lessons where we used "Mapping our World"[17]. The GISAS students also helped us during the lessons. We copied the material for the first chapter "Module one: The basics". This is an introduction to ArcView and I must say that I was fortunate to have 4 persons assisting me because there were some moments of stress when all the difficulties with the network appeared. The problems were solved and we managed to do the whole chapter. The GISAS students made an inquiry and the result was that 50% thought that the "Mapping our World" exercises were good and half thought not. My personal reflection is that American exercises tend to be over-elaborated. But it was a very good experience. Next time I will produce my own material, in Swedish, shorter and more straightforward and with tasks related to the local community.

I bought ortographic photos from "the National Land Survey of Sweden" spring 2006. There were local photos of Bollnäs and some of the villages in the surroundings and if you take the Orto photo together with the digital map in ArcView with 50 % visibility you get a very nice 3D effect. Mr Blixt also helped me to import various data from the Bureau of Statistics in Sweden and this could be used in future exercises with GIS software. The Department for Planning and Construction provided us with local demographic data which could be used in many exciting GIS surveys of the local municipality.

The National Land Survey of Sweden publishes a periodical for their customers all over Sweden and

Figure 3. An Ortophoto together with digital map as described in the text.

they had an article about our GISAS project at Torsbergsgymnasiet in their spring edition. Staff at the Technical Department in Bollnäs council red the article and came to our school interested in some sort of collaboration. We decided to start with a rather easy but nevertheless useful project. All the public wastepaper baskets in Bollnäs city need to be emptied, but there is no map where the locations are registered. Autumn 2006 the year two students will organize the year one students to locate as many baskets as possible with the help of a GPS we can borrow from the Technical Department and the GPS:s we have at school. The type of basket will also be registered. This will help the Department to empty the baskets more efficiently and for instance we could use ArcView to calculate the optimal route for this.

12 Class S2, Geography level B, the extended course, 28 pupils
13 Schools from Singapore, Indonesia, Philippines, Portugal, Germany, Finland and France
14 One about "the Recycling of Household waste" and one about "Bolleberget" a new Nature Reserve in Bollnäs
15 About cultural activities typical for our region, Hälsingland
16 Class S3, Geography level B, the extended course, 27 pupils
17 GIS lessons published by ESRI

Reflections on the GISAS project

This project has been a success. I was very doubtful in the beginning when I became aware of all the obstacles. But now I see that the project is coming to an end and at our school we have benefited greatly. We still are able to have contact with our partner schools since the Comenius[18] time, we have introduced the use of ArcView and GPS in our education and the collaboration with our municipality has increased and improved.

The prolonged time together with our partner schools makes it much easier to go on with the student exchanges we have with many of the countries. The personal contacts are useful in many ways both private and professional. We are now looking forward to see if we can start new projects.

Introducing ArcView in classes is not an easy task. The program is complicated and you have to be aware of all the problems connected with the use in networks. For the moment I do not think that the aim should be to teach all the geography students ArcView in depth. The most important aim must be to show them the possibilities with map software like ArcView. This is achieved best by giving the students practical ArcView exercises where they have to use various GIS data. It's also important to give them examples with a local touch.

When conducting the survey in year three after the "Mapping our World" exercises we found that many of the students who were not skilled in common computer use, found the exercises difficult and boring. Therefore it is important to have exercises designed for different types of students. If there are students who want to go deeper in the software knowledge, I hope we will be able to give them opportunities to do so. Basically, it's more important to give the students examples of how the software can be used in our society, than to give them deep knowledge in the use of ArcView.

The good and extended contacts with many departments at the municipality are a very useful spin off effect of this project and we hope to use them not only when it comes to GIS related issues but also in many other ways. I think that both staff and politicians realize that school not only comes for study visits but also can be a partner to collaborate with.

Mr Tino Johansson[19] had an idea to make a subproject where we should make enquiries about the effect from ArcView work of the student's spatial thinking. Maybe this is on an academic level but nevertheless it is very good and useful that they get a deeper knowledge about how you can build and use the digital map. You can see the increasing use of digital maps all over the society, especially in cell phones, something very close to their own daily lives.

The question of English or Swedish in exercise texts, gave interesting reactions from the year three students. We found roughly half for and half against English texts. I saw this as a good opportunity to practice English in year three[20]. But there is a dilemma, should the lack of knowledge in English affect the degree in Geography?! Personally I would prefer much more English in different subjects for the year three students in theoretical programs. Most of the University literature is in English and this would be a good chance to practice technical language. Unfortunately GIS is connected to the subject of geography but in reality, ArcView is used for planning and presentations in all sorts of industries and government agencies.

We are positive to the project, but there is one big obstacle – it has been very time consuming. We have a very small time reduction for the project but that's not in any way in priority to the extra work.

Dissemination

The year three students have produced two CD's, PowerPoint presentations and folders that can be used in the classrooms but also for other presentations along with material that Ulla and I have produced.

The dissemination of the GISAS project to our colleagues at school has not been, like the dissemination of any project, without problems. Often you meet an attitude like "Oh, out travelling again? ", "Shouldn't you take better care of your students?", "What will this cost our school?", "Do you really have time for this in the geography course?" and so on. Of course you can explain to your closest colleagues but it is

[18] EU Comenius projects 1997-2003.
[19] Mr Tino Johansson, project manager of GISAS project at the University of Helsinki, Finland
[20] At our school English is mandatory year one and two, only a few have extra English year three!

hard to reach everyone. We get time at one of the monthly all personnel conferences in the assembly hall, but often there is heavy time constraint and it is not easy to give the project a fare presentation in 15 minutes. But when it comes to this project I think that all the material we can show and with the collaboration with the municipality, we have met more understanding from our colleagues than usual. There are teachers at school wanting to work with GIS in the future together with us and the principals have been positive all the time.

As reviewed earlier we have good contact with the municipality and staff at different departments and politicians have some knowledge of the GISAS project, but we plan to inform them more when we have produced all the information material.

The National Land Survey of Sweden had an article in their periodical "Gränssnittet" as mentioned before and ULi[21] will publish an article that I wrote about GISAS in their autumn edition. The ULi periodical is widely spread in Sweden and is also published on the Internet. I also have attended different ESRI conferences and GIS-days and have always taken the opportunity to present the GISAS project. When we meet teachers from other schools who are very interested in GIS matters, but most of them feel they don't have the time and the knowledge to start GIS projects like ours. I hope that our project will encourage them!

And the future

The closest plans as mentioned before are the waste-paper basket survey autumn 2006 and information to our politicians.

Making new exercises for the different groups of students studying geography is very important. I will try to make them in different degrees of difficulty, mainly in Swedish and with a local connection. When the opportunity occurs we will increase the cooperation with other teachers and subjects. I am especially interested in cooperation with our English teachers to make exercises in English for the more advanced users. If this is a success I am sure we in the future will have many teachers, hopefully from the Natural Science institution, following us in the use of GIS and ArcView.

I hope we will have increased cooperation with the different departments at the municipality, now that we had this good start. There is a trend in Swedish education that we should search for collaboration not only with public institutions but also with the private industry. The Economic institution at our school has good contacts with local industry and this is something we have to develop. The introduction of GIS in local companies could be a big challenge for Torsbergsgymnasiet.

We have a long and successful history of International projects at the Social Science program at our school and we hope to continue this tradition. When talking to colleagues from abroad we find that GIS is a new and exciting subject area for many. We will try to find partners for GIS projects in the future where we can use our experience from the excellent GISAS project!

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[21] ULi, Utvecklingsrådet för Landskapsinformation, the Swedish Development Council for Geographic Information is a non-profit association, of Swedish organisations, working for more efficient use of geographic information. http://www.geoforum.se/

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Evaluating the GISAS project: Constraints and challenges

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Introduction

As part of his research project, an upper secondary school student aged sixteen used Geographical Information Systems (GIS) to make a map to investigate the distribution of coffee shops in his city The Hague, The Netherlands (Korevaar & Van der Schee, 2004). Coffee shops in the Netherlands are well-known selling points for soft drugs and are concentrated in inner cities. With data from the yellow pages in the local telephone book the student made his map and discovered a concentration of coffee shops in the inner city, see Figure 1 which can be explained by concepts as accessibility and concentration of amenities. During his study the student learned that, according to the law, coffee shops should not be located within 500 meters of a school. The student mapped out all schools in the Hague using public data and made buffers of 500 meters around the coffee shops.

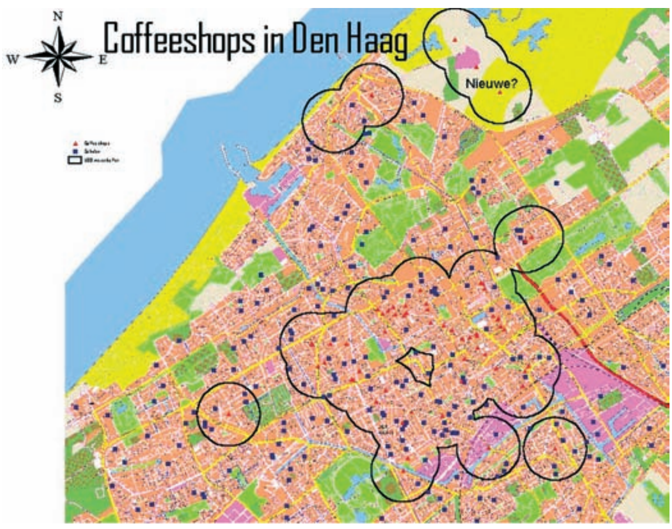

Figure 1. Coffee shops in The Hague, a GIS application of a secondary student.

Combining the two maps in a GIS programme the student discovered that many coffee shops are too close to schools, indicating that the State had reason to revoke their permission to operate legally. Based on these results the student wrote a report for the local newspaper. This investigation was part of the student's geography examination assignments. It shows that mapping different layers of spatial information with GIS may stimulate geographical thinking.

Outside schools, GIS is spreading fast in human activities today (Schleicher & Lawrence, 2005: 84). The application of this technology is increasingly being found in such areas as environmental, resource and hazard management, infrastructure and planning. The use of GIS in precision farming, city administration, health care and geomarketing is booming. Using GIS means more information and more flexible and accurate information. GIS helps to analyse all kinds of issues in our world where space is involved (Longley, Goodchild, Maguire & Rhind, 2001). GIS skills are part of modern citizenship (Houtsonen, 2003; Lemberg & Stoltman, 1999).

Although the number of people using GIS in modern society is growing fast, the technology has not been adopted by educators at a rate commensurate with expectations. Since its inception as a desktop application for professionals in a wide range of occupations in the early 1990s, GIS has diffused slowly in educational contexts worldwide and then, largely only into select elite primary and secondary classrooms. In his study on the status of GIS in the United States, Kerski conducted a national survey of educators in the 1520 high schools that purchased GIS software by 2000. These high schools represent less than 8 percent of the estimated 20.000 public and private high schools in the United States. He found that only half of the educators who owned the software were using it and of that number, a mere 20 percent used it in more than one lesson in more than one class. His other findings included that teachers think the software is complex, they lack time to develop curriculum to use GIS, and they have little technical and instructional support (Kerski, 2003). GIS's failure to be widely adopted in classrooms in the United States may be attributed to teacher training (Bednarz & Audet, 1999) and to inadequate research on its effectiveness in promoting significant learning in geography and science (Baker & Bednarz, 2003). It is also clear from surveys that GIS has been slow to be adopted by educators because of its technical complexity. Teachers sometimes do not use GIS to avoid frustration by students who are better in using software than they are. However, also students' first steps in GIS are connected to frustration about the complexity of mastering the software, and as soon as you start to work on the next step, most of the knowledge from the previous lecture seems to be lost (Schleicher & Lawrence, 2005). Nevertheless educators believe that computer technology has the power to transform education into innovative learning and teaching situations (Donert, 2005:22). GIS in education has just started and new initiatives are necessary to overcome the growing pains. Students doing research using GIS is already reality in some schools. Interesting and useful information about American students doing environmental research with GIS can be found in 'GIS in schools' (Audit & Ludwig, 2000).

This contribution evaluates the Geographical Information Systems Applications for Schools (GISAS) project. The GISAS project was a three-year education and research project funded by the MINERVA Action of the European Commission. The GISAS project introduced Information and Communication Technology in education by bringing GIS into secondary school geography and environmental education. The aim of the project was to develop ways in which GIS can be applied in secondary education and teacher training. GISAS helped to introduce GIS in secondary education by inquiry-based learning. The GISAS project focused on water quality research with GIS.

The second section of this contribution gives information about the aims, method and results of GISAS. The third section offers some reflections about a successful further introduction of GIS in Europe.

The GISAS community of learners

The GISAS community of learners consisted of seven schools in seven EU countries. The participating schools were:

1. Sint-Dimpna College – Belgium
2. Second Lyceum of Larissa – Greece
3. Holy Heart Institution - France
4. Torsberg Gymnasium – Sweden
5. Piero Gobetti Liceo Scientifico Statale – Italy
6. Széchenyi Ferenc Gymnasium – Hungary
7. Gaigalava Elementary School – Latvia

The GISAS project started in the autumn of 2003 and was finished in the autumn of 2006. The project was coordinated by the Department of Geography of the University of Helsinki. The Josef Stefan Institute from Slovenia and the National Board of Education of Finland were partners in the project. Two evaluators from other countries than the participating schools were added to the project to keep an eye on the quality of the project.

Objectives

GISAS helps teachers to use GIS in schools and to create a model for the use of GIS in secondary education (Johansson & Kaivola, 2004). The GISAS project focus was that students in secondary schools should gather water-related environmental data in different European countries, link it into a common GIS database and analyse and discuss water quality information as a community of learners. The project aimed to develop GIS skills of students and teachers and to develop and disseminate ideas about the use of GIS in secondary education. The project was a test case for other schools in Europe.

The following objectives were formulated:

1. To introduce GIS into European secondary schools.
2. To create a model on how to incorporate GIS into secondary school geography and environmental education.
3. To organise virtual in-service training on GIS.
4. To create educational materials and a web-based learning environment for teachers and their students.

5. To test and develop these outputs in real-classroom situations with the help of partner school teachers.
6. To investigate how GIS is used in secondary education.
7. To develop and support international cooperation among teachers and students in web-based learning environments.

Figure 2 shows the GISAS aims split up for the three years of the project.

YEAR 1: Take-off phase
- To get all participants involved in the project.
- To supply all participants with the GIS tools.
- To train all participants in the use GPS and GIS.

YEAR 2: Try-out phase
- All participants run pilot projects in their schools.

YEAR 3: Evaluation and dissemination phase
- Investigate and evaluate the effects of the GISAS pilot projects.
- Disseminate the ideas using networks of schools and teacher training institutes.

Figure 2. GISAS aims per year.

Important GISAS products foreseen at the start of the project were a web-based atlas and the use of groupware as discussion and communication platform for teachers participating in the project.

Organisation and evaluation techniques

Meetings organised every half year were central points during the GISAS project. These two-day meetings were used to make the participants familiar with the project, to train GIS skills of the participants (see Figure 3) and to discuss the problems faced executing the project in the local school environment. Apart from these meetings the use of BSCW groupware as a forum of collaboration and discussion was very important. This groupware enabled the sharing of files and enlarged the common responsibility of the participants.

Figure 3. GIS workshop by during the second GISAS meeting.

To collect information about the project different evaluation instruments were used:

A. Observations and interviews during the meetings.
B. An analysis of questionnaires.
C. An analysis of studies made by others involved in the project.
D. An analysis of the use of BSCW groupware as a forum of collaboration and discussion.
E. An analysis of power point presentations made by participants to show the state of the art of the GISAS project in their school setting

Results

One of the main results of the GISAS project is an European web atlas about water quality in all the languages of the participating countries. Figure 4 shows a part of the Hungarian contribution. Students of the Széchenyi Ferenc Gymnasium in Barcs investigated the water quality of the river Drava on the Hungarian –Croatian border. Like all other schools they used the BISEL (Biotic Index at Secondary Education Level) method, see figure 5. The biological water quality was related to geographical characteristics as land use and drainage systems. The students were trained in the use of GPS to be able to locate their field measurement points. Data were transformed into a set of ArcView maps which are very instructive for students in other schools to learn about the water quality situation near Barcs.

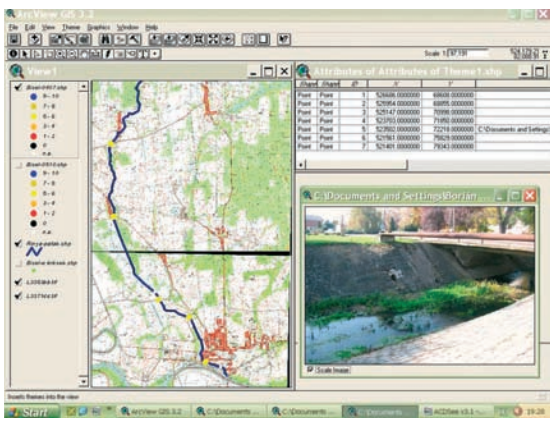

Figure 4. Hungarian input for the GISAS web atlas.

Figure 5. Belgian students using BISEL to evaluate the water quality.

A second important piece of work in addition to the web atlas is a manual 'How to work with ArcView' in all the languages of the participating countries.

Interviews and questionnaires at the end of the second year of the project showed the participation of 190 students in the GISAS projects on a voluntary basis. Most of them were between 14 and 18 years old. The average numbers of participating teachers per school was three. Most of them were teachers in geography, biology or computer science. The GISAS lessons were a mixture of inside and outside lessons. In some countries lessons were dedicated to train other teachers to work with BISEL and GIS.

Common activities across borders were organized for the pupils of the participant schools. Apart from a successful videoconference excursions were organised to other schools. Latvian pupils spent six days in Belgium, Hungarian pupils one week in Belgium and Italy. Being together joint GPS training exercises and water quality analyses were organised. These exchange visits between GISAS partners were arranged to learn about other countries, their culture and their local water quality project. Teachers reported that these exchange visits stimulated international understanding. These events excellently represent the general philosophy formulated by the EU for projects like GISAS.

The teachers reported that most students liked it to work with GIS because it challenged them to analyze real life situations with modern tools. For teachers it was a fascinating but not an easy challenge to develop learning environments to facilitate students to learn in this modern way.

As the results of the first questionnaire at the start of the project showed almost none of the participants had experience in teaching about or with GIS and all participants requested more training in GIS. Although five out of seven countries reported in the second questionnaire at the end of the first year that they were pleased with their progress, the lack of GIS skills and geographical knowledge were still identified as the main obstacles to attain immediate goals. Many participants also faced practical problems such as a lack of time, money, and adequate tools.

Nevertheless at the end of the second year of the project the participants reported many positive aspects. The participating countries stated that the GISAS outdoor activities are useful and popular and that the co-operative atmosphere of GISAS promotes self-confidence and creativeness. Summarizing the activities of the students the participants reported that the students like to present their GISAS work to other people; students like GISAS because it is modern Internet technology; students like project exchange visits to other countries and geocaching; GISAS motivates students and it motivates extra when the GIS lessons are part of regular school work or an examination. In addition, the participants were glad to learn and work together in an international group to make the GISAS project a success and to get their colleagues in school involved into the GISAS-activities.

When we look back at three year GISAS project points that catch the eye are:

1. The great investment of time and energy by the Finnish organisers and almost all participants. Although not all participants were geographers or environmental specialists, the group of people involved in the project was motivated and hard working. Not just the students but also the teachers learnt a lot about GIS in education.
2. The big differences between the project partners. Working with participants from very different parts of Europe, speaking different languages and with different levels of computer experience and computer technology in their schools it was not easy to make GISAS a success. Different teacher' expertise in geographical analysis and GIS and different opportunities to integrate the GISAS project in the curriculum made the project go on faster and smoother in one country than in an other. Also the support in the schools was different. As in the French school the headmaster supported the participation of all teachers in his

school the Greek participants had much more problems to get their colleagues involved.
3. The combination of international excursions and high-tech student research projects was a good formula. The international excursions were no official part of the GISAS project and financed from other EU projects. However, the combination of research and excursions stimulated co-operation between schools in different European countries in schools in different ways.
4. GISAS was a very complex project combining new technology with student research, outdoor education and international discussions. GISAS was new for the teachers and involved many students.

Seen all the constraints mentioned before the commitment of the participants as well as the progress and output of the project as a whole is laudable. The dissemination of GISAS to other schools was started in some countries, however, here a lot of work has to been done. Almost all other objectives of the GISAS project were achieved.

Constraints and challenges

Learning with GIS is essential for modern citizenship. Introducing GIS technology in secondary education will be a success if teachers and students get the facilities and opportunity to learn about GIS and to learn to work with GIS in a community of learners.

It is not easy to work fast in a project with participants from very different backgrounds. The importance of mastering technological skills and domain specific knowledge should not be underestimated. To overcome local constraints strategies should be developed to help individual participants who ask for more individual support. In situ training in addition to central meetings seems to be necessary.

GIS is a challenge to learn and to use in the classroom, but many funded GIS projects such as those sponsored by the US National Science Foundation and GISAS use full-blown, industrial strength software not adapted for classroom use. The learning curve for the software is steep; configuring ways to manage its use in learning is not self-evident to most teachers. While simpler software is available it is often not well supported for classroom use beyond a series of disconnected lessons. Teachers express a willingness to learn a software if they perceive that it will benefit their students but it needs to be relatively easy and provide a significant learning advantage for students, that is, be well-integrated into the curriculum (Bednarz & Van der Schee, 2006). The Dutch EduGIS (www.edugis.nl) is a good example of a user friendly GIS portal for primary and secondary education. Although at the end of the project most GISAS participants claimed good progression in working with GIS, the GIS training during the project could have been more professional with attention for stepwise and flexible learning units and learning processes.

Last but not least the development of thinking skills should go side by side with learning new technologies. Without reflection on the product and process of GIS supported students' research projects there will be no renewal of existing teaching and learning. Using GIS in the learning process represents a challenge to educators. Traditional forms of schooling treat knowledge as a fixed commodity to be delivered from teachers to students. Many teachers and students are focused on facts and concepts, not on generalizations and relationships. Modern teaching, in comparison, strives for understanding, a process in which learners must play an active part. This epistemological shift requires teachers to develop a deep and broad understanding of their subject matter and to foster new pedagogical strategies. Teaching with and about GIS has little to do with traditional teaching (Bednarz & Van der Schee, 2006). It requires striking a balance and moving teachers out of old ways of thinking while maintaining a strong connection to real practice (Stone Wiske, Sick & Wirsig, 2001). GIS requires and capitalizes upon higher order thinking skills. In order to foster such skills teachers and students may need to work in new ways such as through enquiry-based methods and problem based learning (Audet & Ludwig, 2000).

To evaluate a development is fair when the growing pains are gone. GISAS was a first step and a good first step. But many steps should follow. GISAS tried to combine design, implementation as well as the dissemination at the same time. As the design and implementation was quite successful, apart from some very successful presentations in conferences the dissemination did not go further than the take-off phase. Also the effects of GISAS for teacher training were limited. A follow-up of GISAS is advisable to further improve the model for incorporating GIS into secondary school geography and environmental education. More attention for dissemination of the concept should be high on the agenda because 'all students deserve and need the opportunity to be challenged, to be supported, and to become critical spatial thinkers' (National Research Council, 2006: 241). More attention for projects like GISAS in teacher training courses should be pursued for 'GIS software products possess many of the requirements of a powerful support system for thinking spatially in general and in the K-12 context in particular'(National Research Council (2006: 176)'. Teacher training should encompass the issue how teachers should help students to structure the information new media give us about the world (Van der Schee, 2003: 212).

The GISAS project was instructive for secondary education in Europe. It was a good initiative to stimulate the application of GIS in secondary education combining knowledge and skills from different disciplines and working together in an international community of learners. That the complexity of the project caused some delay in achieving some of the projects objectives was the price that had to be paid for working in an international and ecological valid situation.

Seen the fast growing importance of GIS in modern society the question is not whether we should introduce GIS in education but how. The GISAS formula seems to be a successful one to enable students in different countries to think critically about important issues in their world like water quality or the distribution of drugs.

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APPENDIX 1. An example of the monthly e-learning exercises for the partner schools.

How to create new shapefiles for different land use types?

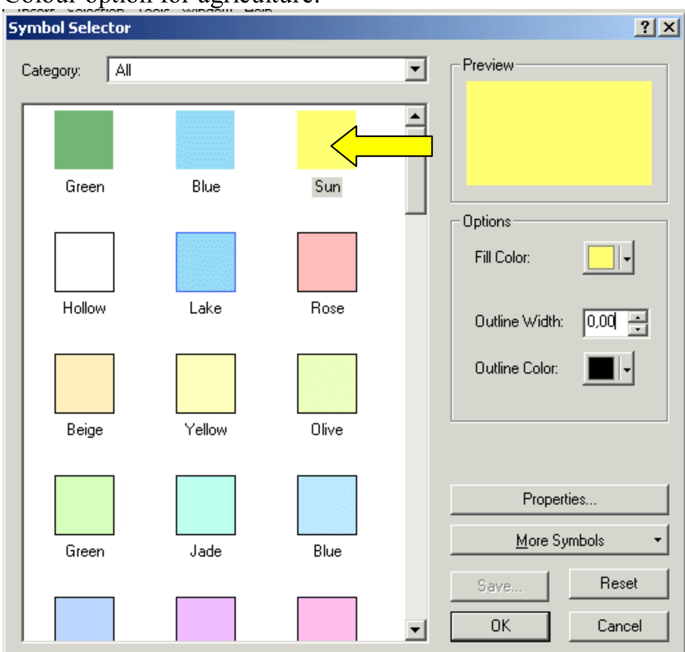
Your task is to create polygons, which will show the different land use types found on the vicinity of the river on the map. Our task is to define six main land use type categories. Each category will be drawn on its own layer as a polygon shapefile. The instructions below will only show you the steps of drawing the first land use type shapefile. In order to carry out this task, you must repeat these steps with the other five land use type shapefiles, too.

The land use types, which we will create on the map are:	**shapefile name**
1. Agriculture (including pastures, fields and fallow)	**agriculture**
2. Forest (including coniferous and deciduous forests)	**forest**
3. Residential (housing)	**residential**
4. Industry and commerce (factories, shopping centres, offices)	**industry**
5. Water (lakes, ponds, reservoirs)	**water**
6. All other (land use types)	**others**

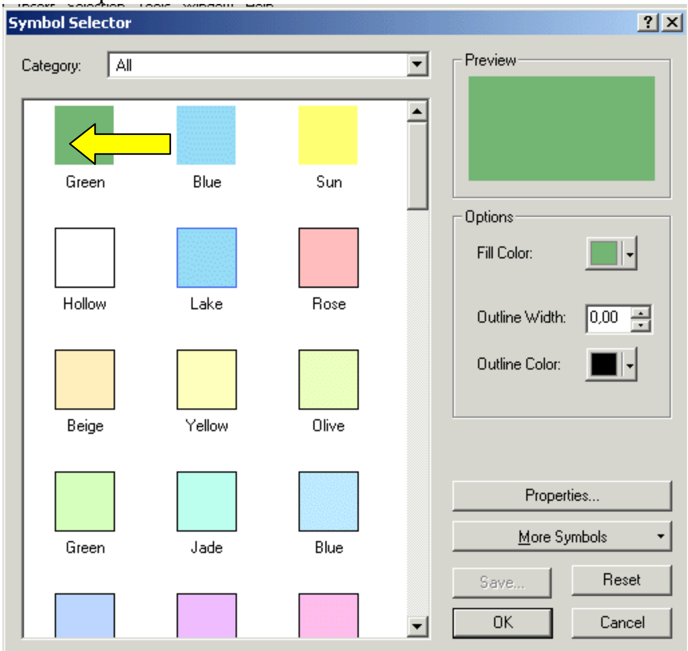
The figures of this instructional manual use the shapefile name **land use**. You should, however, use the correct shapefile names from the beginning (see list above).

You will define the colour for each land use type in step 8 of this document. The figures below show you the colours of each land use type and you must use these because else it is difficult for other users to know what land use type is in question if the same land use type has different colours. Notice that only water has an outline width more than zero!

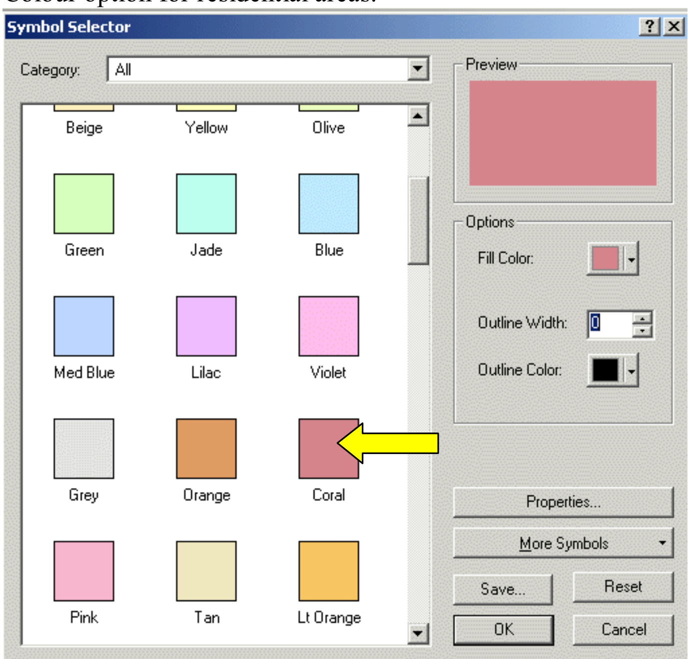
Colour option for agriculture:



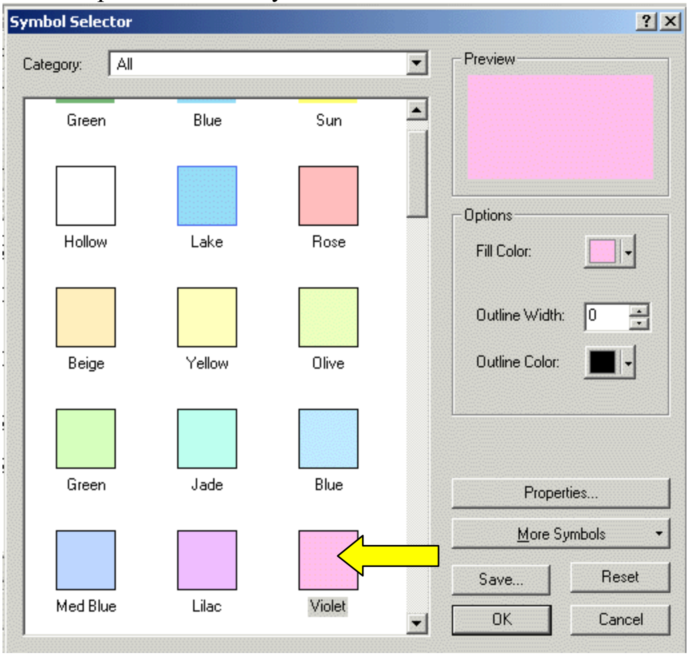
Colour option for forest:



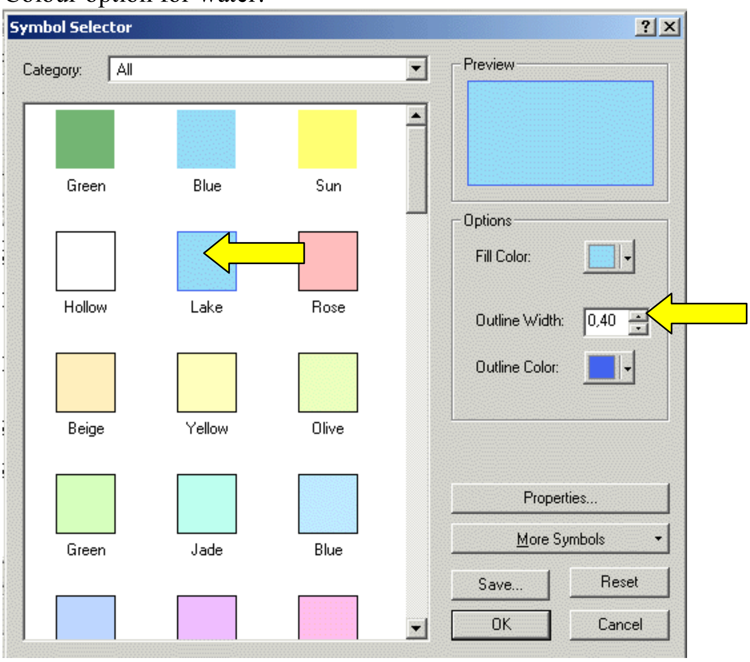
Colour option for residential areas:



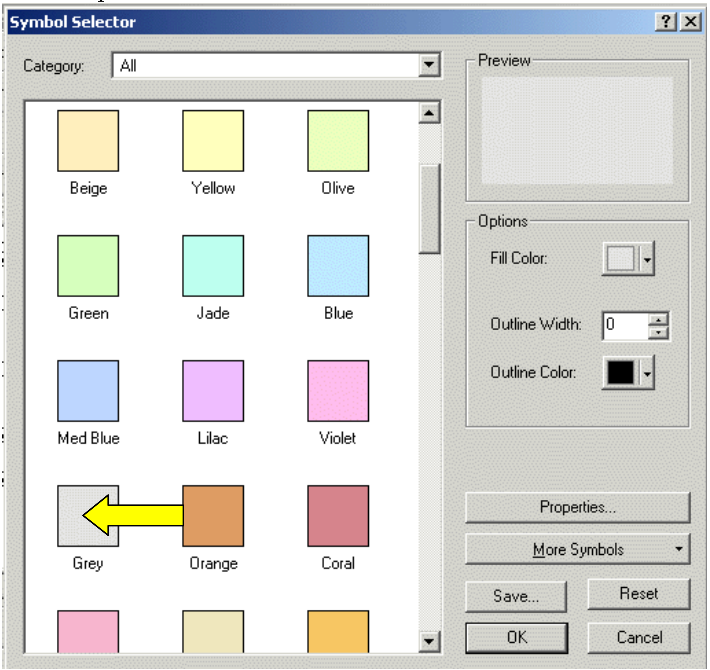
Colour option for industry:



Colour option for water:



Colour option for others:



STEP 1.

Open ArcCatalog and locate the GISdata folder, which was created in your workstation during the first exercise by group number 1. Select it and click it open with your mouse. Then go to the File –command, select New ⇒ Shapefile.

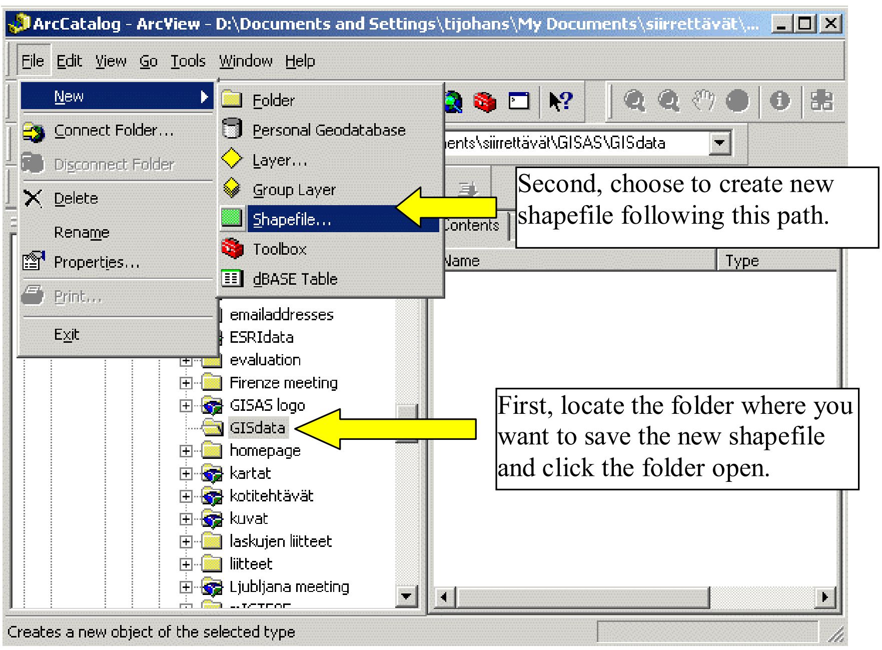


Figure 1. The first steps of creating a new shapefile on your map.

STEP 2.

On the next window, you will give a new name for your shapefile and define the feature type from the drop-down list. Notice, that for rivers, roads and railways, the correct feature type is polyline. But for area objects, such as recreational areas, forests, pastures and land use types, **the correct feature type is polygon**. Point feature type is used for single map objects, such as houses, trees and water analysis points (BISEL).
So, first name your new polygon type shapefile with the name **land use**.

Second, change the feature type from point to polygon, using the drop-down list (see figure 2). For this exercise, the correct feature type is **polygon**.

Third, define the spatial reference of your new shapefile to be the same as your area's raster map, namely WGS84 coordinate system. You will start the defining by clicking the Edit-button (see figure 2).

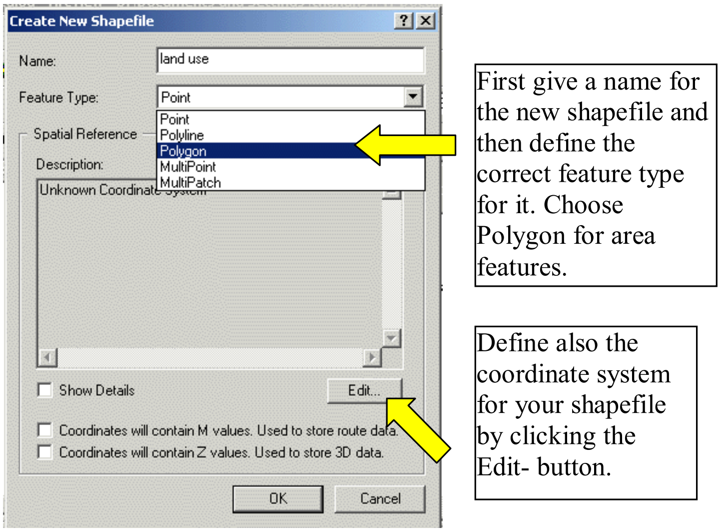


Figure 2. Select the correct feature type for your new shapefile.

STEP 3.

Now, the Spatial Reference Properties –window opens. There you will be able to define the coordinate system in many ways. The easiest way is to use the predefined coordinate systems. Click on the Select –button and open a new window, where you will select the correct coordinate system, which is the same as your raster map's coordinate system (see figure 3.). On the Browse for Coordinate System –window open first the Geographic Coordinate Systems –folder and then World –folder and finally select the WGS 1984.prj –file with your mouse and click the Add –button to finish your selection of a predefined coordinate system (see figure 4 on the next page).

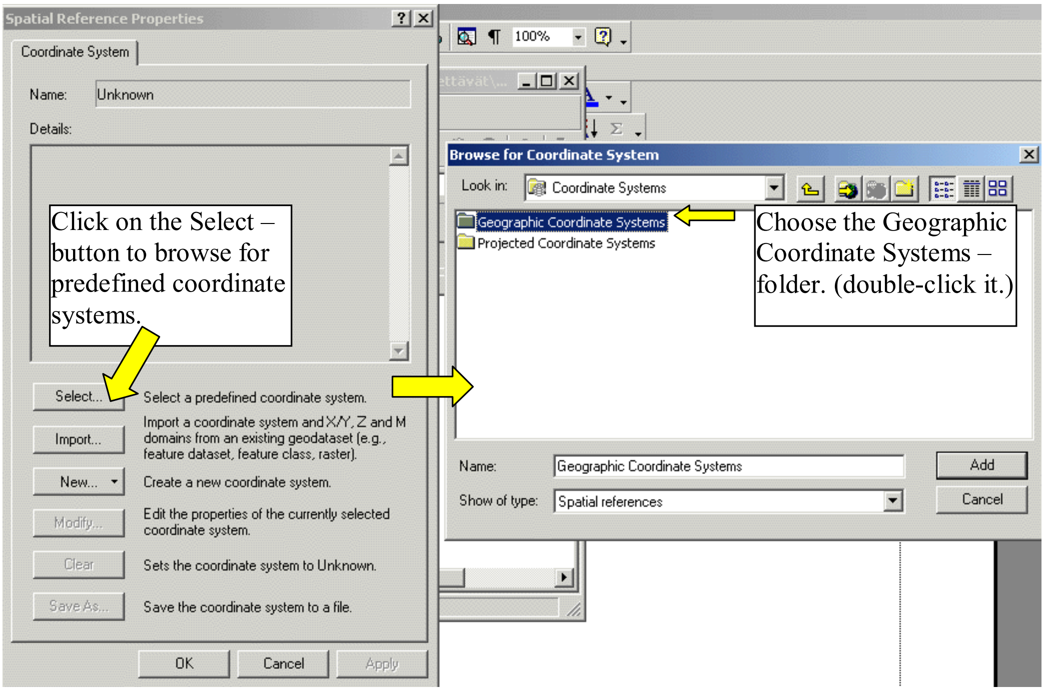


Figure 3. The spatial reference (coordinate system) can be defined easily with predefined systems.

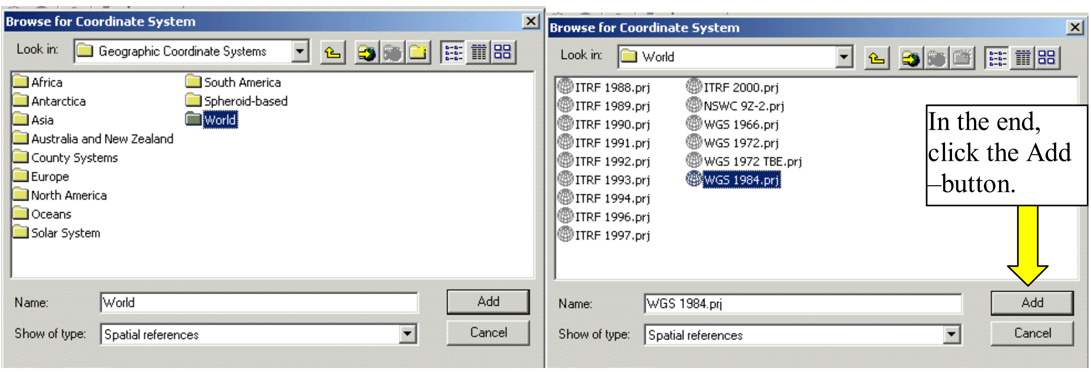


Figure 4. Follow these instructions to the correct predefined coordinate system.

Now you will return to the Spatial Reference Properties –window, where the details of your selected coordinate system are shown. In this window, you will first click the Apply –button once and then click the OK –button once. You have now defined a coordinate system for your new shapefile (see figure 5).

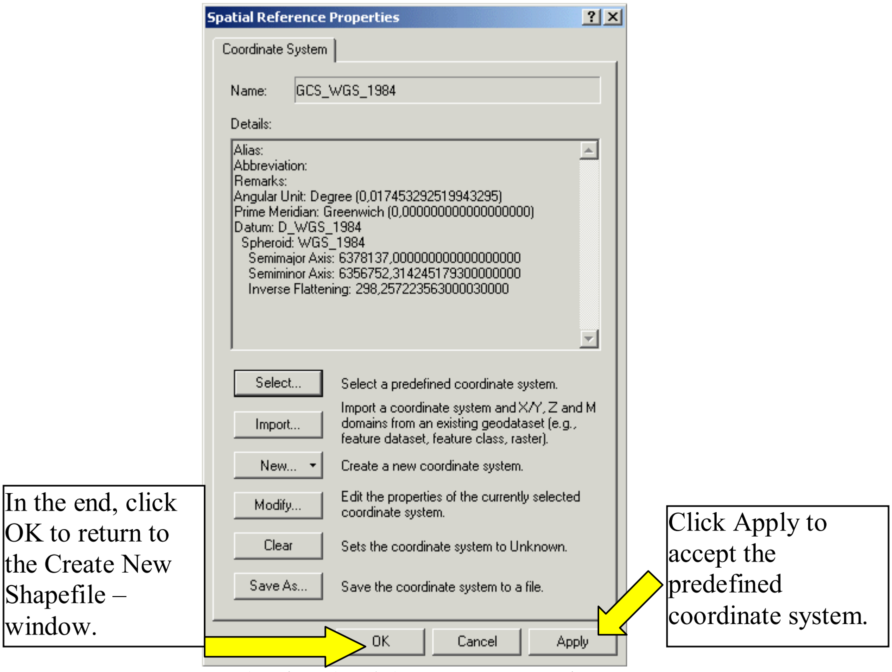


Figure 5. The details of the WGS84 coordinate system.

Finally, you are able to make the final definition of the attributes of the new shapefile. All the previously defined values are now visible on the opening window.

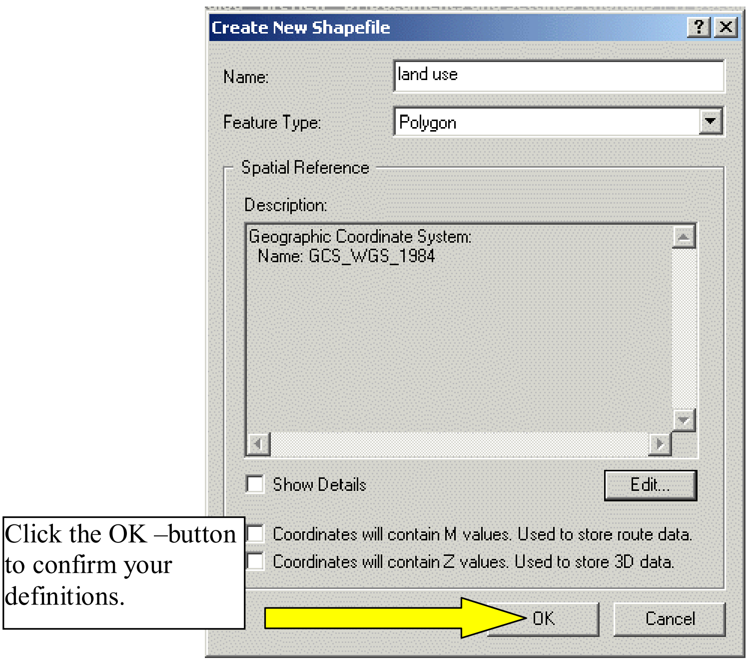


Figure 6. Your window should look like this.

Now, take a look at the ArcCatalog –window and the list of folders on the left. There you will see your new shapefile when you open the GISdata -folder. It is also shown on the right-hand window.

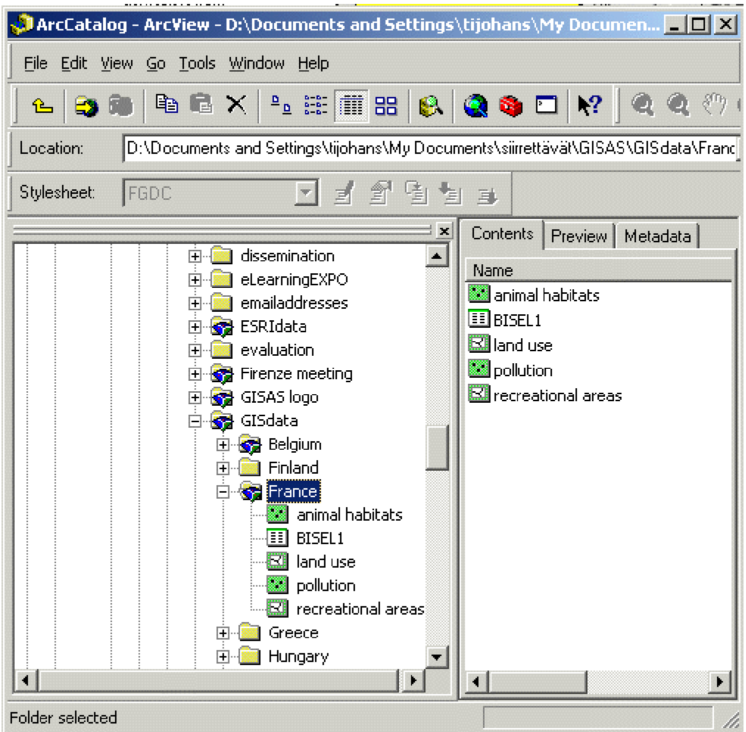


Figure 7. The new shapefile is now created in ArcCatalog.

STEP 4.

Open ArcMap and select An existing map, which you saved in exercise one and then click OK. See figures 25 and 26 of the instructions for group number 1 document to find out the right file structure, which is opened in here. By opening an existing map you simultaneously open all the layers stored in that map. Open the map, which has the registered raster map and the other shapefiles of your area.

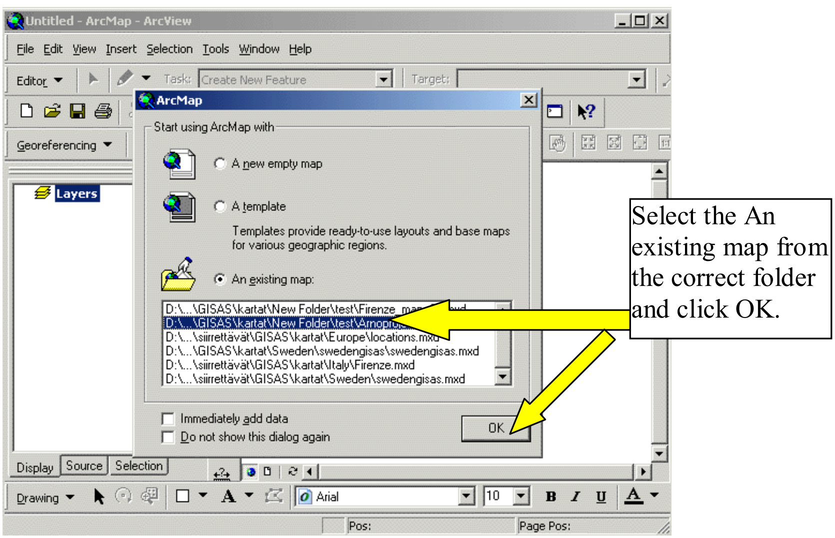


Figure 8. Open an existing map to ArcMap.

Then place the land use shapefile into the Table of Contents of ArcMap by dragging the file with your mouse from the ArcCatalog –window to the ArcMap –window. Drag it on top of the list above the title of your raster map.

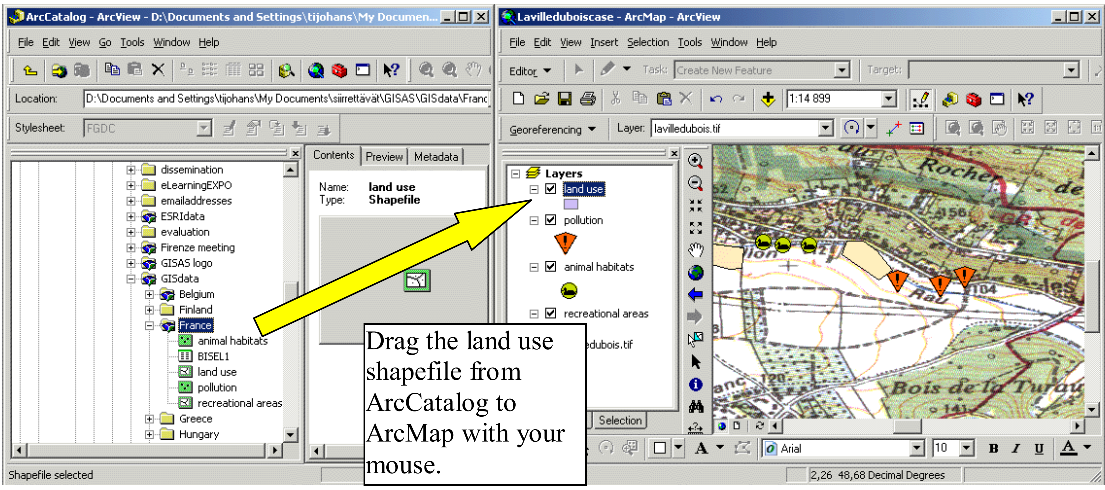


Figure 9. Place the new shapefile on top of the Table of Contents of ArcMap.

Now you have an empty land use shapefile in ArcMap. It is sometimes useful to temporarily close some other distracting shapefiles from the map project in order to better draw new elements there. You may now click on the square on the left-hand side of the shapefile titles on the table of contents to remove the cross from there and make the shapefiles invisible. This must be done when you create the other five land use type shapefiles because else the already drawn polygons will cover the raster map and it is difficult to focus on the exact location of the land use type in question.

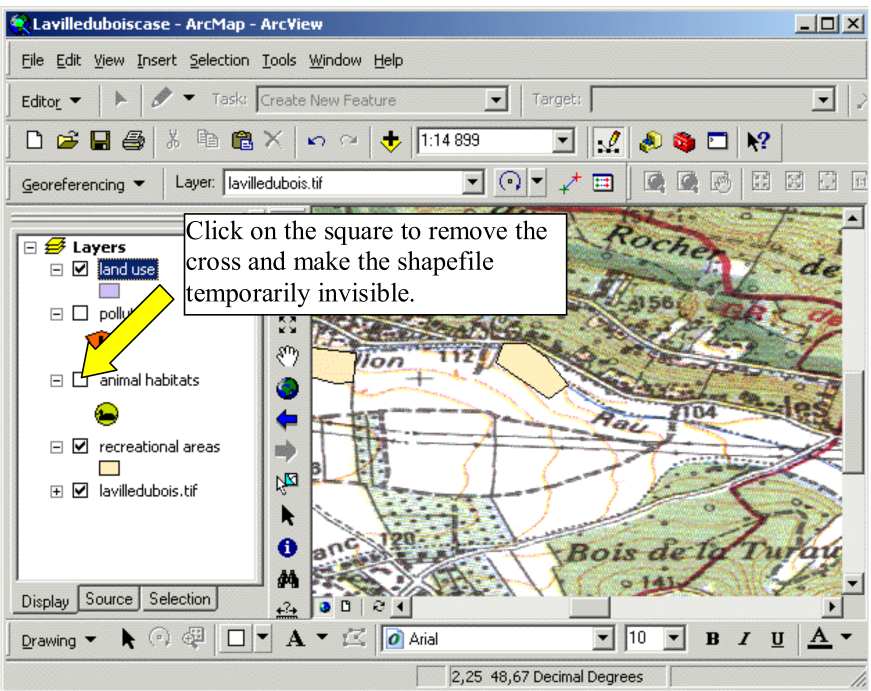


Figure 10. The visibility of the shapefiles can be easily controlled in ArcMap.

It is easier to draw new features on the map if you make some overlaid shapefiles invisible on the map. This does not mean that the shapefiles disappear from the map project completely but only become invisible there as long as you like.

STEP 5.

Click on the title of the shapefile on the Table of Contents of ArcMap. The go to the Editor Toolbar.

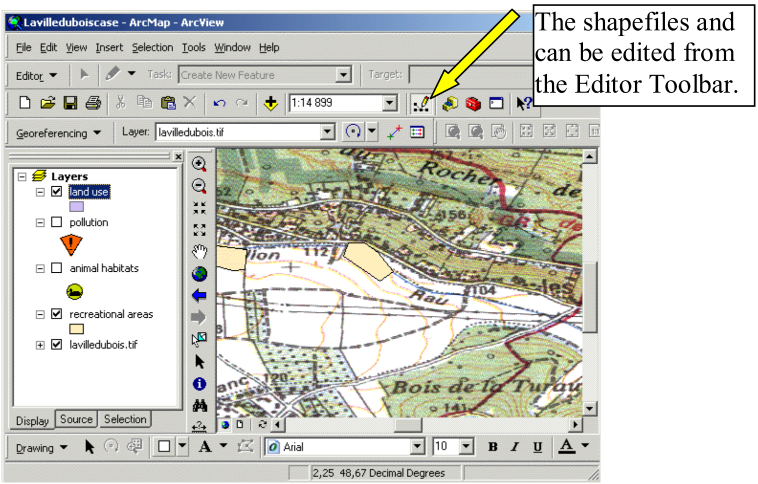


Figure 11. Activate the shapefile by clicking it and then select the Editor Toolbar.

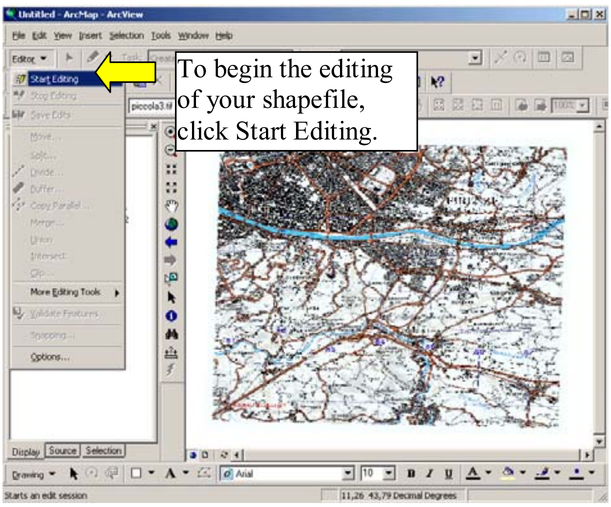


Figure 12. Start editing command activates the editing tools in ArcMap.

Now you have activated the editing tools in ArcMap and you are able to start drawing a polygon with some of its tools. First, zoom in to the raster map to get a clear and close view of the river area where the land use type areas will be drawn. You should zoom into the first land use type on the map.

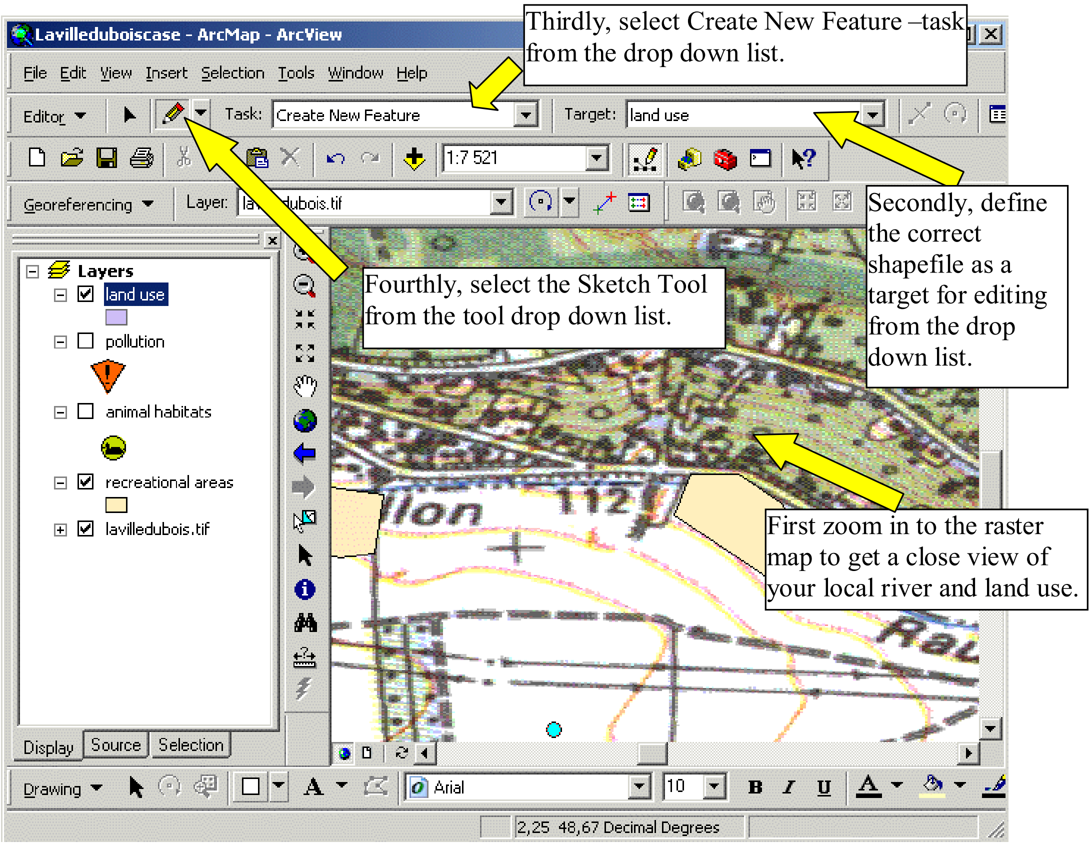


Figure 13. Define the task and the right tool before you start to edit the new shapefile.

Now you can start to draw the land use areas along the local river with the sketch tool. First left-click once with your mouse on the first corner of the polygon. Left-click once on the second corner of the polygon with your mouse and then move towards the third corner. Now you can see a polygon shape connected to the mouse pointer. Your task is to define the borders of the polygon by left-clicking on each of its corners. On the last corner double-click and complete the polygon.

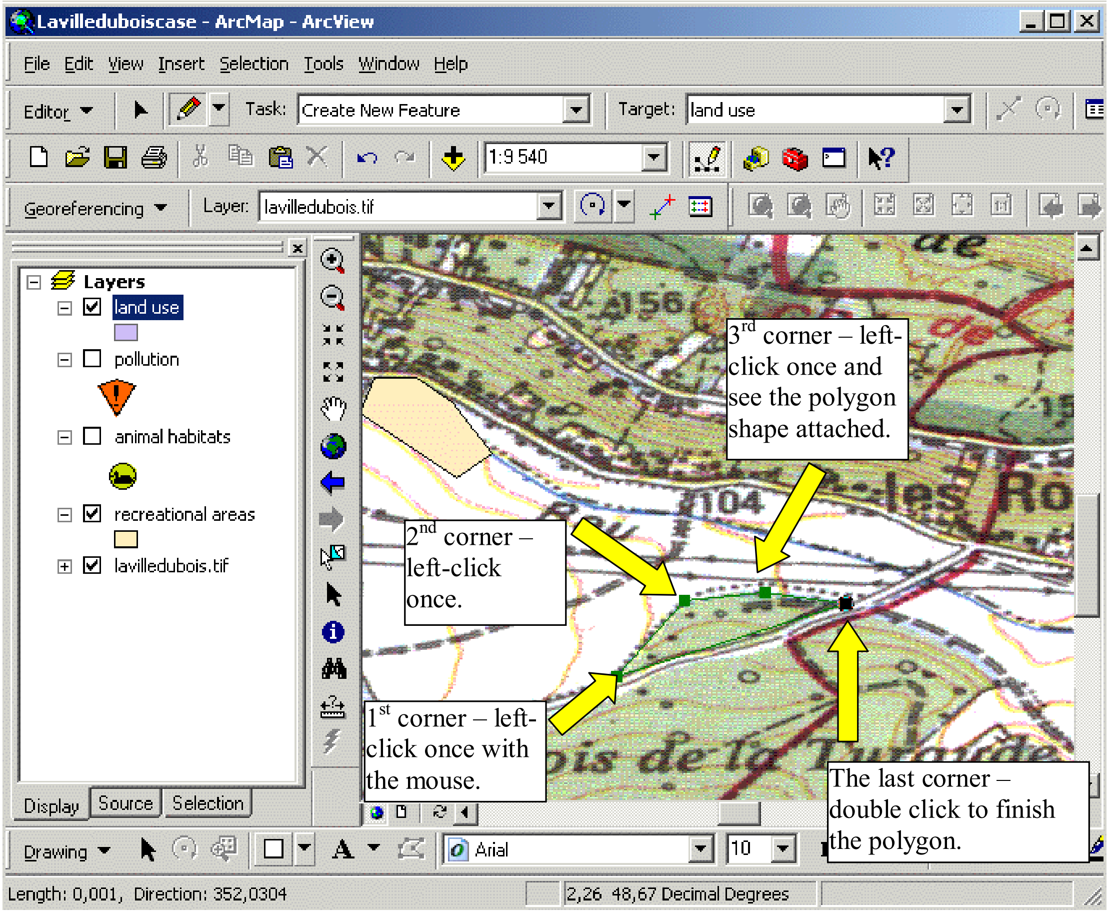


Figure 14. Drawing a polygon takes place with the Sketch tool.

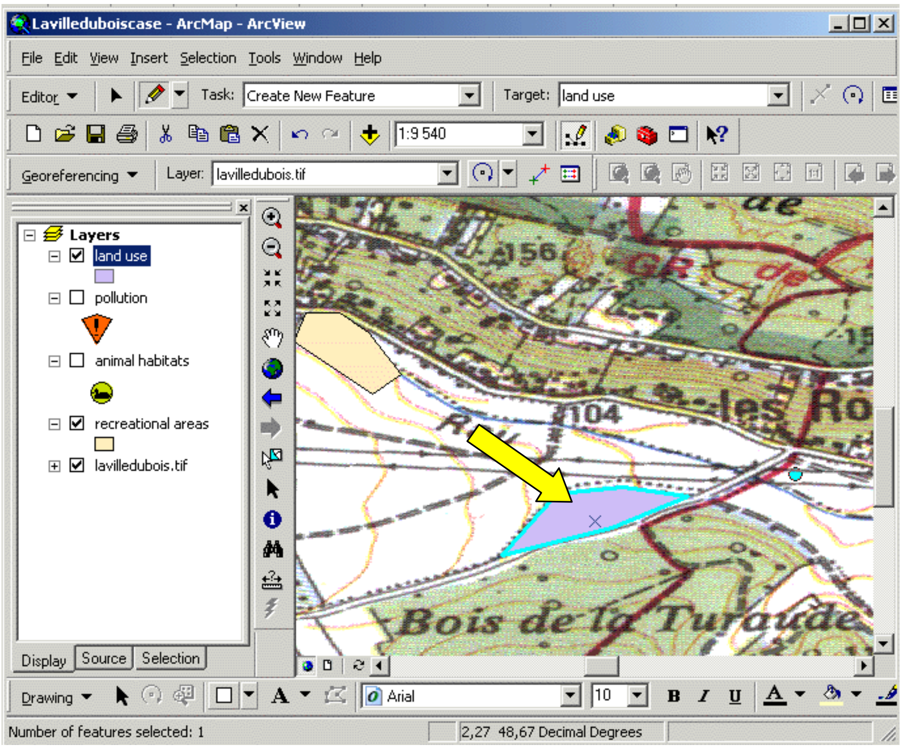


Figure 15. The new polygon appears after a double click on the last corner.

Now continue to draw all the same land use type areas as polygons on your map by selecting the sketch tool active and repeat the left-clicking operation in each polygon. You may start by drawing first the agricultural areas, such as pastures, fields and fallows.

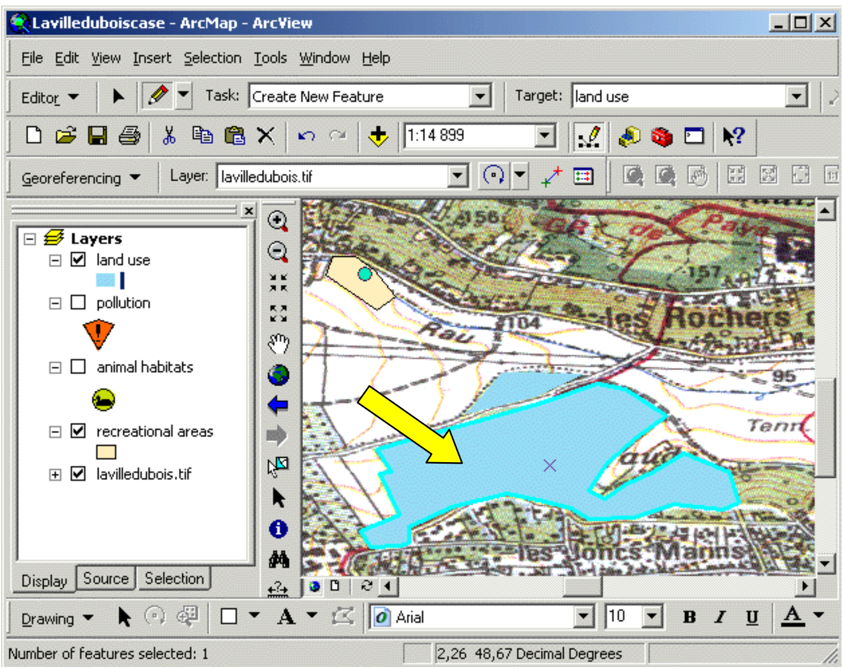


Figure 16. Additional polygons will be drawn easily with the same tool.

Save the polygons every now and then from the Editor –button and select Save Edits. In the end, select Stop Editing.

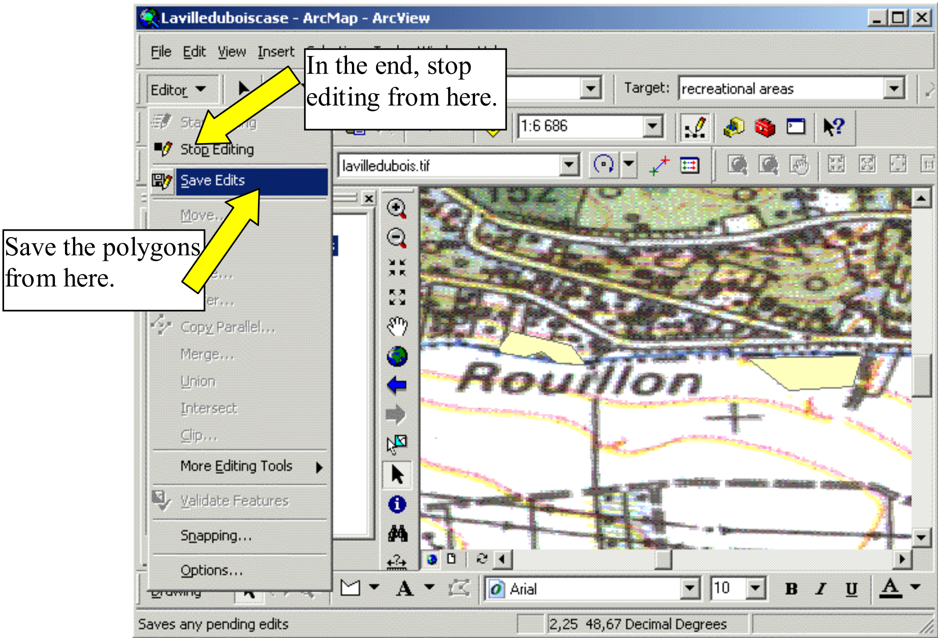


Figure 17. Save the drawn polygons from the Editor drop down list.

Now carry out the same steps for each land use type mentioned in the beginning of this document and create all six shapefiles. Continue then to step number 6.

STEP 6.

The next task is to add a new column to the attribute table of the pollution database table. This is done with ArcMap. Open the attribute table of the first land use type shapefile by right-clicking on the title and selecting Open attribute table (see below).

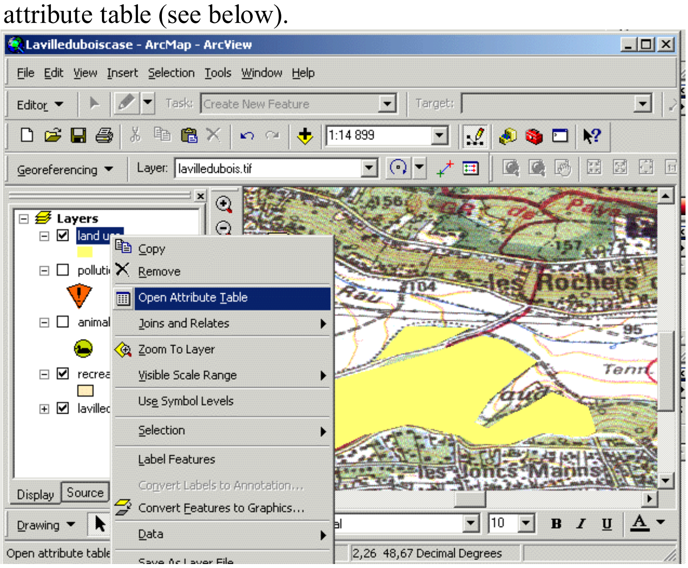


Figure 18. Open the attribute table of your first land use type shapefile.

Then the attribute data table of the first land use type shapefile opens and it has three fields and one row for each polygon you have drawn (see figure 19). You should next add a fourth field to define the land use type for each polygon more precisely. Select Options and then Add Field.

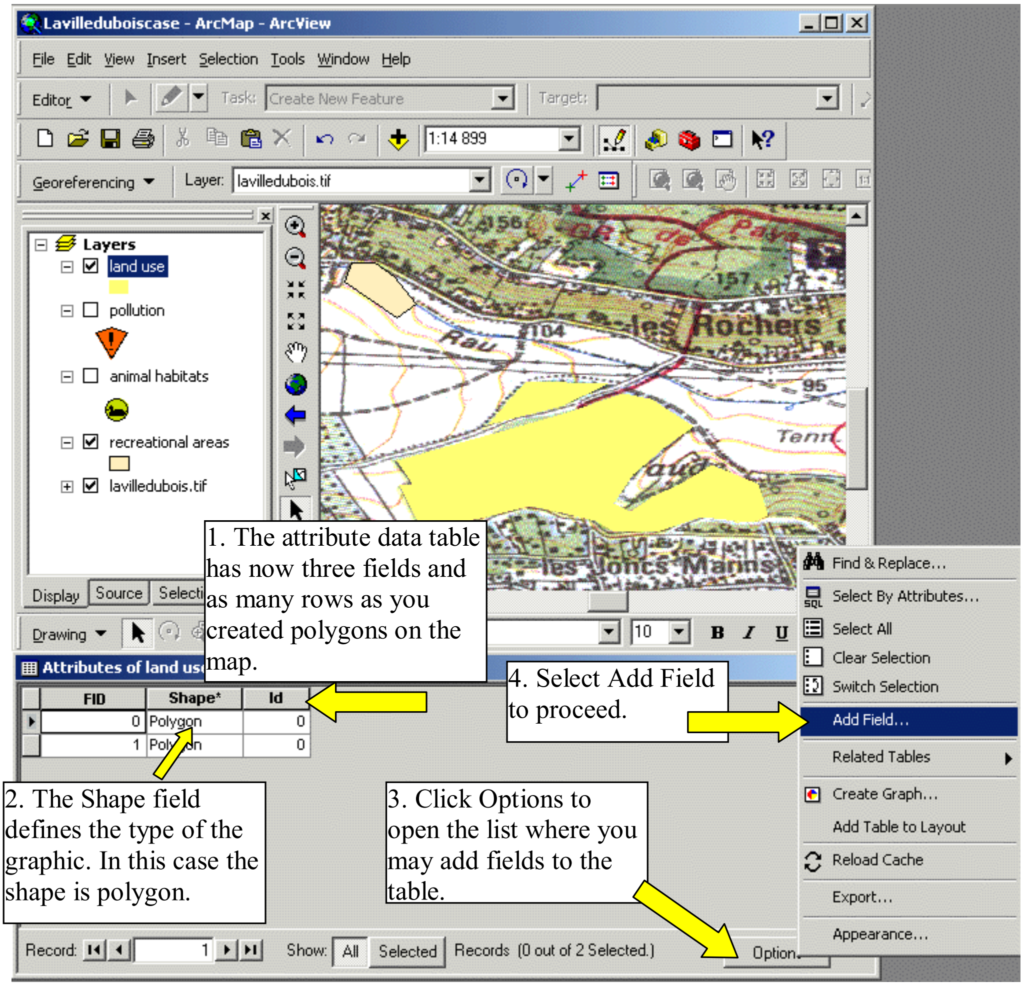


Figure 19. Attribute table contains the attributes of the polygons on the map.

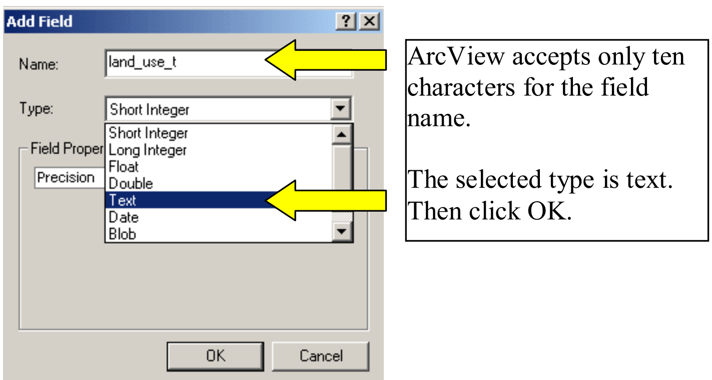
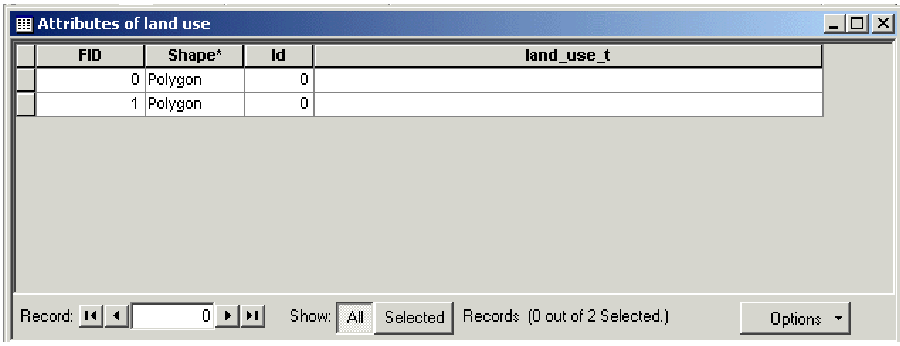


Figure 20. Give a field name and define the type of data for each field.

As a result, you will get a new field for your attribute data table.



FID	Shape*	Id	land_use_t
0	Polygon	0	
1	Polygon	0	

Figure 21. A new field has now appeared on the attribute data table.

Now, start editing again the land use shapefile by selecting Start Editing from the Editor tool. You can identify the row for each polygon object on the map by selecting one polygon on the map with the Edit tool (arrow) and then take a look at the attribute table where the row representing that polygon is highlighted in blue background colour (see figure 22). Now type in the precise land use type on the highlighted row for each polygon in turns. Double-click on each row to be able to feed in the data. The land use types for farming could be, for example, pasture, fallow, crop field, potatoes, corn, and so on. The land use type for forests could be, for example, deciduous forest, coniferous forest, thicket or mixed forest. Give also an id number for each polygon and type it as an ordinance number on the Id column. Once you are finished, go to the Editor tool -drop down list and Save edits. Then select Stop editing to finish. Repeat this exercise for all your land use type shapefiles.

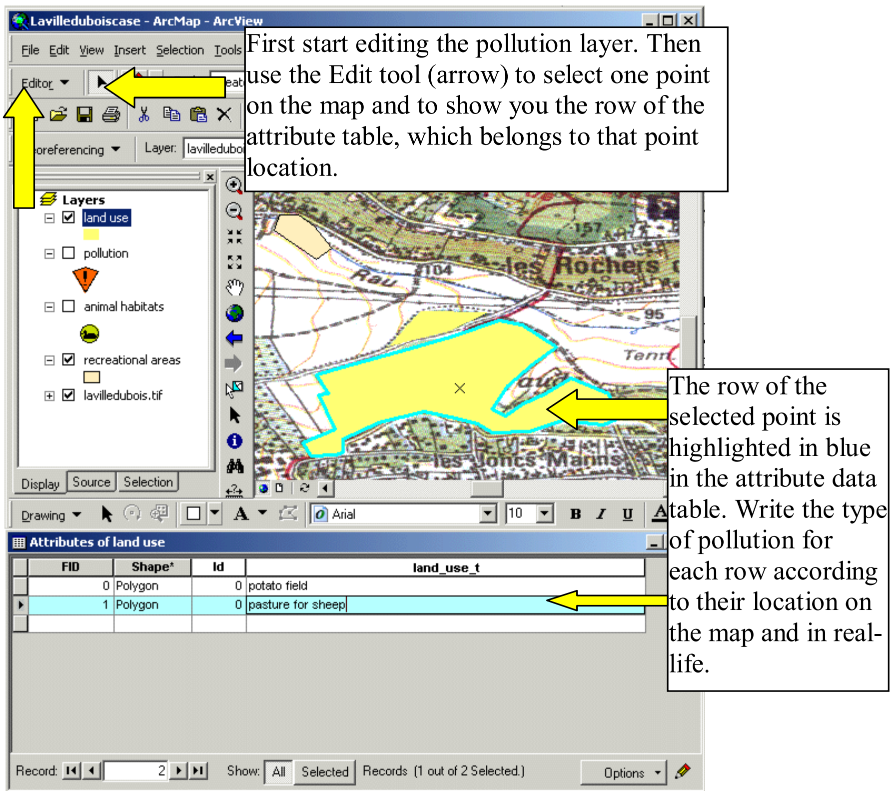


Figure 22. Define the land use type for each polygon by using the Edit –tool.

STEP 7.

Now you have added attributes to your map objects and learned that there is a connection between each map graphic and attribute table rows. A graphic on the map shows the location and geometric shape of an object. The attribute table stores the attributes of that object. Close now the attribute data table.

You can now use the Identify –tool to query each land use type polygons precise land use.

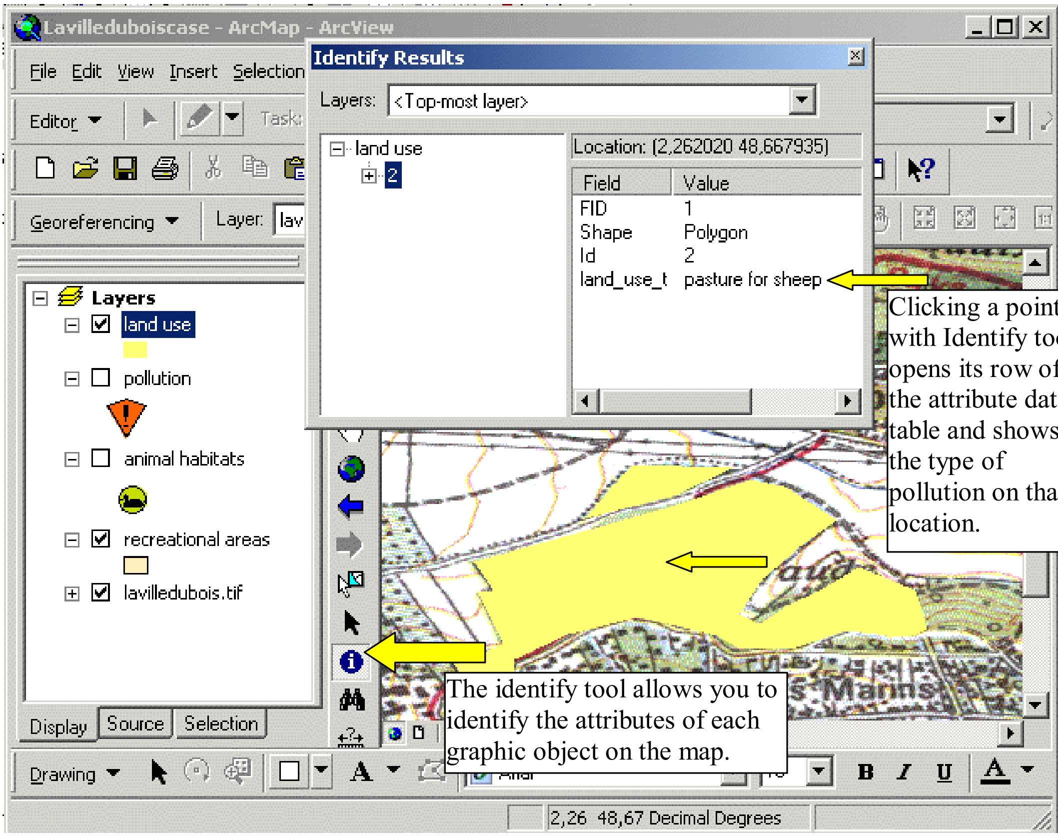


Figure 23. The identify –tool allows you to query the attributes of each polygon.

Take a few minutes to query your polygons on different land use type shapefile layers. Then close the identify –tool.

STEP 8.

The final task of this exercise is to change the fill in colour of the polygons. Although we have defined the different land use types into the attribute data table, we will have to give a certain colour for the land use type polygons belonging to the same land use category in order to separate those visually from the polygons of the other land use categories. The instructions for the choice of colours are in the beginning of this document. Follow the instructions and colour definitions for each land use type shapefile.

First, open the polygon colour palette by left-clicking once on the rectangle below the land use title.

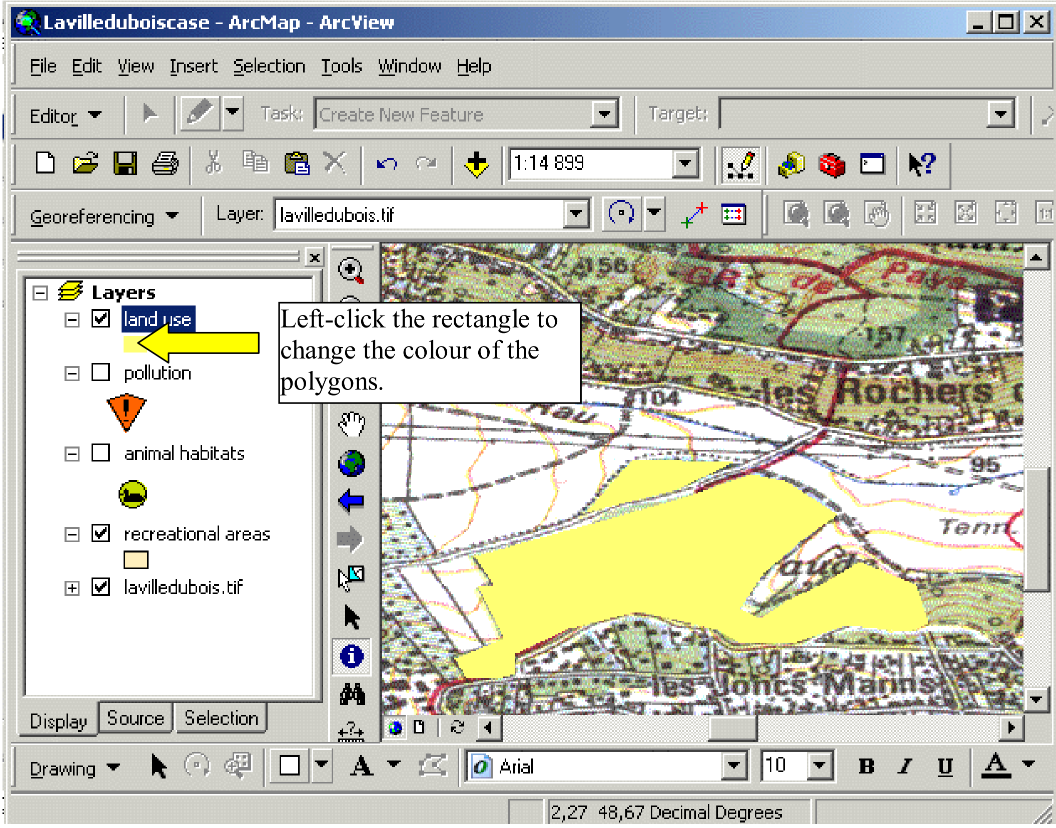


Figure 24. The colour, shape and style of the graphics can be changed from the List of Contents.

Now a Symbol Selector –window opens. The content of the window depends on the type of the graphics the shapefile contains. If the shapefile contains polygons, the available Symbol Selector choices are of different coloured polygons. If the shapefile contains lines, then the choices in the opening list are of different types and colours of lines and so on. Now follow the instructions and colour specifications, which are in the beginning of this document.

Select Sun (yellow) colour for the agriculture land use type areas as a common distinctive colour. Use your mouse to pick the right colour from the list and then click OK

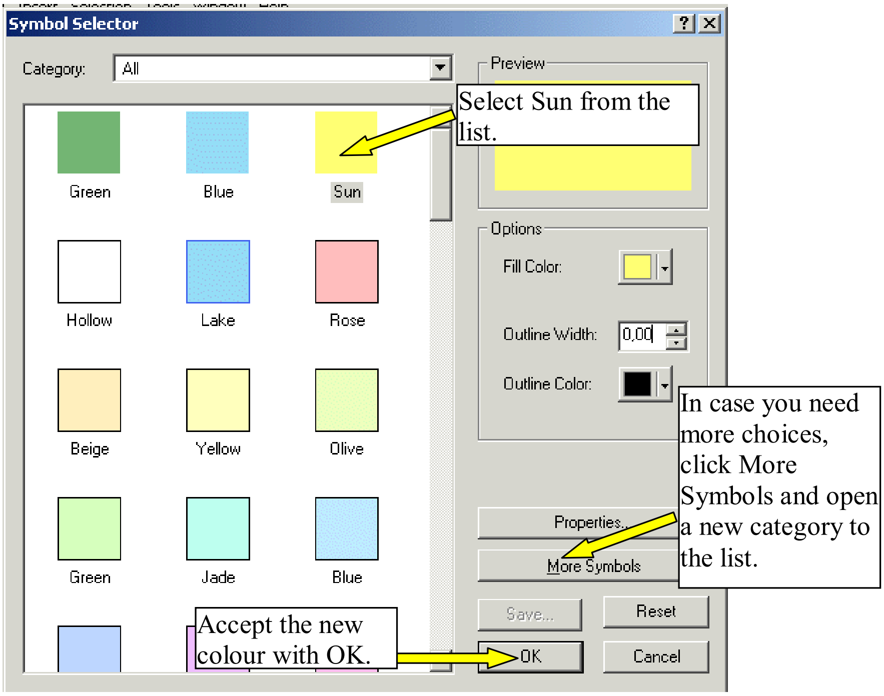


Figure 25. The choices on the list depend on the type of the shapefile selected.

The colour of your polygons is now changed and you may see this on the map window as well. Define the colours for all your land use type shapefiles in the same way.

STEP 9.

Before you will finish this task, remember to save the existing map by selecting File ⇒ Save. This is how you will save the colour definitions for the future use when you open the map project again.

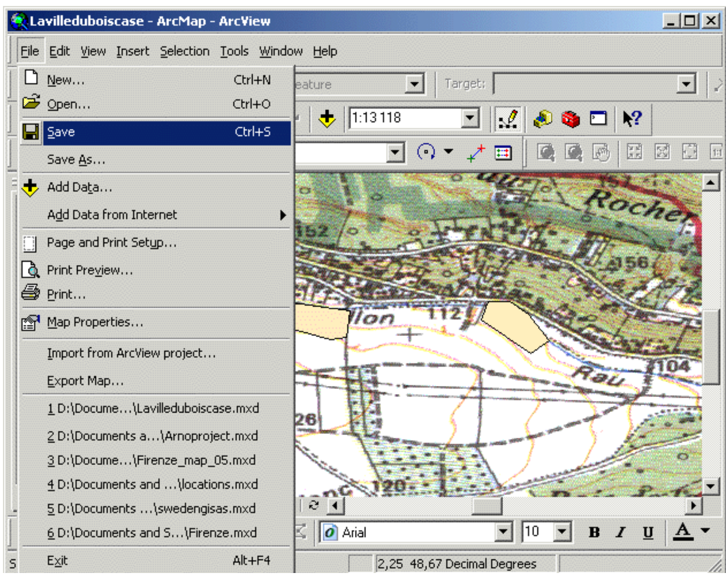


Figure 26. It is important to save your edits also to the existing map project.

Now, you are able to open your land use polygons and raster map as well as the river with only one selection when you open ArcMap and select Open an existing map.

Thank you very much for your effort! We hope that this exercise was interesting and you learned to create new polygons, which represent different area objects on your local map.

You have now completed the eLearning tasks for the spring term 2005. The produced map project and each shapefiles as well as other files related to them must be zipped and uploaded into Bessie under GISAS Cooperation > Studies> Your institution > Monthly e-learning activities > April05 –folder. Remember to zip all files, which have the same name, for example, if you created one land use type shapefile, you get six related files as a result (see figure 27 below.)

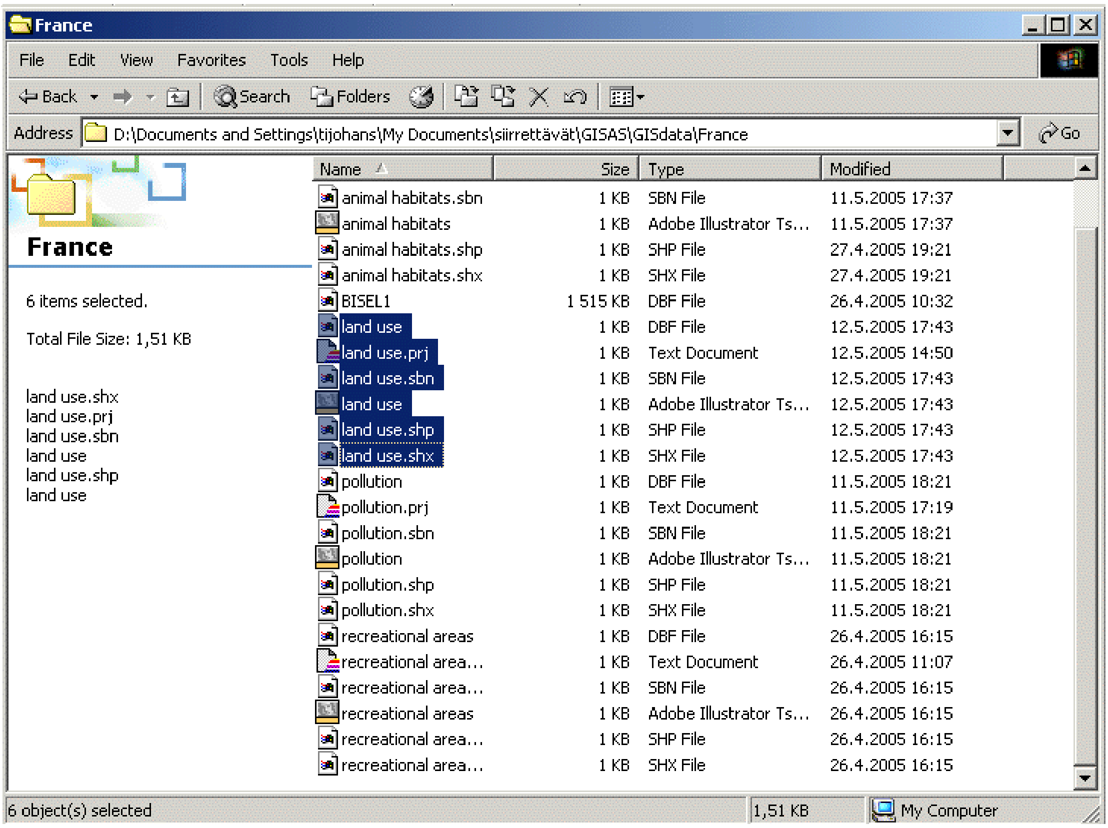


Figure 27. Remember to select all related files for zipping your shapefiles.

If some of the files is missing and not uploaded into the Bessie with the zipped package, the other users are not able to open your shapefiles correctly with their ArcView software.